PROJECT REPORT

ON

SMART AGRICULTURE SYSTEM BASED IOT

A Report submitted in partial fulfilment of the requirement for the award of certification of

Internship

In

SmartBridge

Submitted by

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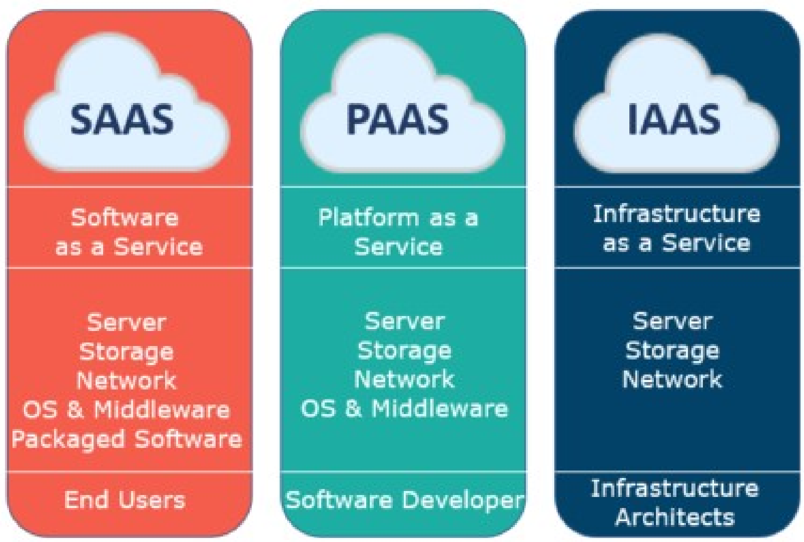
CHAPTER-1

INTRODUCTION

1.1 OVERVIEW

1.1.1 Cloud Computing

Cloud technology enables the reusability of IT resources for storing large databases, developing and hosting complex applications, and expanding computational power and other services on demand. Eliminating or reducing investments on large-scale infrastructure and software, coupled with the pay-per -use model, significantly reduces IT costs.



Types of Cloud Computing Services

1.1.2 Cloud Deployment Models

What are the most popular cloud deployment models? There are four types of them: public, private, hybrid and community clouds. Additionally, there are also distributed clouds, multiclouds, poly clouds and other models, but they are not so widespread.

A cloud deployment model is a specific configuration of environment parameters such as the accessibility and proprietorship of the deployment infrastructure and storage size. It means that deployment types vary depending on who controls the infrastructure and where it resides.

- **Public Cloud**

  The name speaks for itself: public clouds are available to the general public, and data are created and stored on third-party servers. Server infrastructure belongs to service providers that manage them and administer pool resources. Provider companies offer resources as a service both free of charge or on a pay-per-use basis via the Internet connection.

- **Private Cloud**

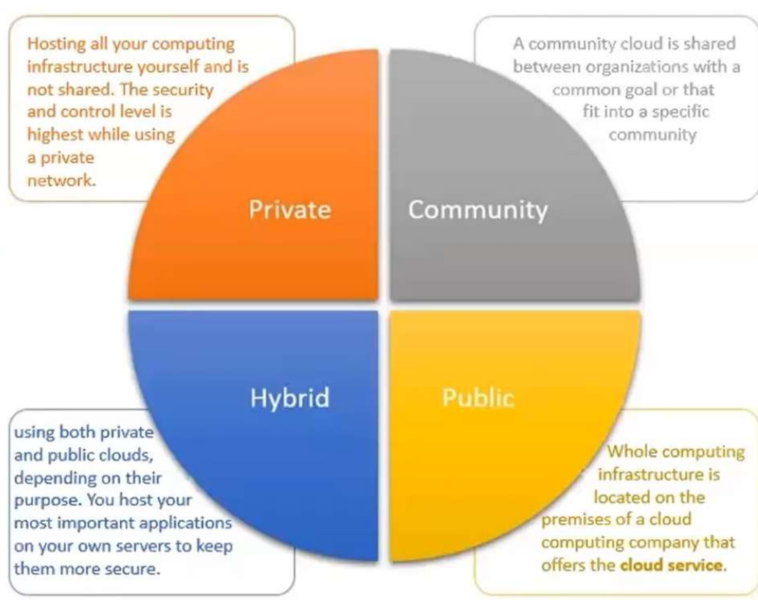
  There is little to no difference between a public and a private model from the technical point of view, as their architectures are very similar. However, opposed to a public cloud that is available to the general public, only one specific company owns a private one. That is why it is also called an internal or corporate.

- **Community Cloud**

  A community deployment model largely resembles a private one; the only difference is the set of users. While a private type implies that only one company owns the server, in the case of a community one, several organizations with similar backgrounds share the infrastructure and related resources.

- **Hybrid Cloud**

  As it is usually the case with any hybrid phenomenon, a hybrid cloud encompasses the best features of the above-mentioned deployment models — public, private and community ones. It allows companies to mix and match the facets of all three types that best suit their requirements.



1.1.3 What we have today

In areas where rain doesn’t come regularly or when growing water-hungry crops, farmers are forced to get creative. Irrigation uses groundwater, surface water, and water delivered directly to farms to hydrate thirsty plants.

Evapotranspiration and wind are issues farmers face when trying to get water to plants while avoiding waste. General access to water and a diminished supply are also struggles for farmers in many parts of the country.

There are multiple ways to irrigate. Research has backed numerous effective application strategies, but each farmer has their own preference and budget.

- **DRIP IRRIGATION: WATER TO THE ROOTS**

  One approach to getting plants the moisture they need is by sending water directly to the roots with a drip irrigation system or a subsurface drip irrigation system. A drip system is made up of hoses with holes throughout that pump water directly to plant roots within the soil. While this irrigation method is more expensive, farmers see a reduction in water applied. Drip can also be beneficial to oddly shaped or loped fields.

  Today, precision mobile drip irrigation (PMDI) exists, which is in essence a hybrid of drip and centre pivot irrigation. PMDI uses drip hoses on a centre pivot system, rather than nozzle heads, to get water to plants without getting wheel tracks wet or investing entirely in a drip system.

- **CENTER PIVOT IRRIGATION**

  This method of irrigating involves long steel arms and sprinkler nozzles and pivots, normally electrically, around a center base to reach the entire field.

  When it comes to fertilizations, the farmers manage injections themselves, but *having remote control* has helped the family dedicate more time to field scouting and nutrient management.

1.1.4 Why we need to change

In India, outdoor water uses alone averages more than 9 billion gallons of water each day, mainly for landscape irrigation. As much as 50% of this water is wasted due to overwatering caused by inefficiencies in traditional irrigation methods and systems. Smart irrigation technology is the answer.

Smart irrigation systems tailor watering schedules and run times automatically to meet specific landscape needs. These controllers significantly improve outdoor water use efficiencies.

Unlike traditional irrigation controllers that operate on a pre-set programmed schedule and timers, smart irrigation controllers monitor weather, soil conditions, evaporation and plant water use to adjust the watering schedule to actual conditions of the site automatically.

For example, as outdoor temperatures increase or rainfall decreases, smart irrigation controllers consider on site-specific variables, such as soil type, sprinklers' application rate, etc. to adjust the watering run times or schedules. There are several options for smart irrigation controllers. Smart Agriculture system based on IoT.

1.2 PURPOSE

The key objective of the paper is to monitor the soil's moisture content during its dry and wet conditions with the aid of a moisture sensor circuit, calculate the relative humidity and irrigate it based on its nature using a PC based IOT and GSM system and an automatic water inlet setup which can also monitor and record temperature, humidity and sunlight, which is constantly modified and can be controlled in future to optimize these resources so that the plant growth and yield is maximized.

A record of soil moisture, temperature, rainfall is maintained in a database for backup. This backup is used for weather forecasting and directs the farmers regarding the type of crop to be cultivated in future. IOT gives the whole info to the operator about the irrigation.

CHAPTER-2

LITERATURE SURVEY

2.1 EXISTING PROBLEM

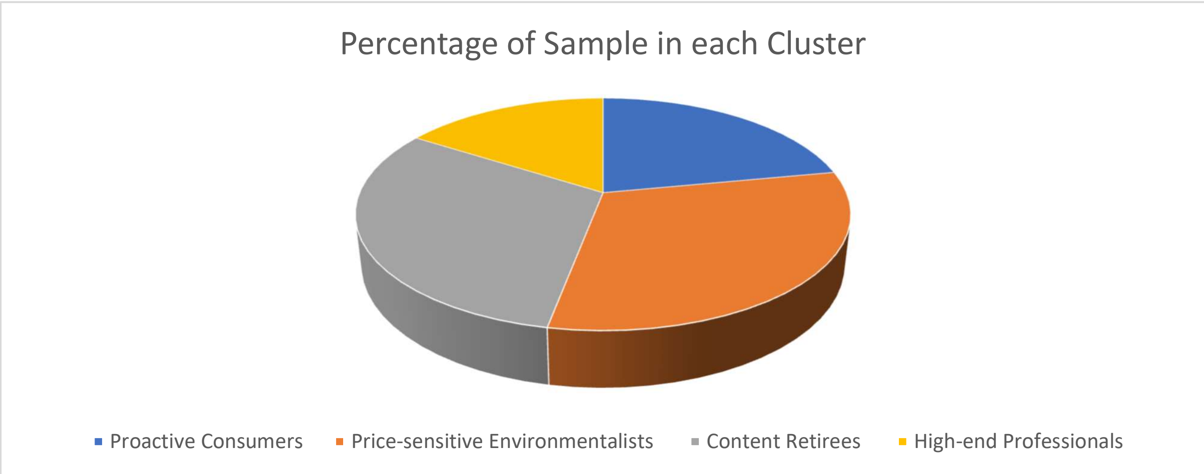
A Ward's linkage cluster analysis was used to cluster participants into homogenous segments based on their responses. Four distinct clusters were identified and titled as Proactive Consumers (22%), Price-Sensitive Environmentalists (31%), Content Retirees (31%), and High-End Professionals (16%).

Proactive Consumers were well-read about irrigation-related topics and wanted more info about water usage. This cluster was the most considerate with regards to future outcome of their actions but was not very environmentally conscious.

Price-Sensitive Environmentalists were the least well-read about irrigation-related topics. However, their conduct can be influenced by instruction and information, they consider future outcome, and they are environmentally conscious.

Content Retirees were fairly well-read about irrigation-related topics, but they were less worried about the future consequences of their actions or the environment.

Unlike the other clusters, the High-End Professionals were not strongly impacted by future outcome or environmental factors.



2.2 PROPOSED SOLUTION

- Overall, having children in the household played a key role in determining whether respondents were receptive to purchasing/installing smart irrigation technologies. This likely stems from parents and guardians wanting to preserve natural resources for future generations.

- Alternatively, since smart irrigation systems ultimately save the homeowner money, these respondents may consider the systems as financially solvent investments where they ultimately conserve money that can be used on other family-related items, experiences, and needs.

- SMS systems were the best-received smart irrigation controller. This implies there may be more opportunity to promote these controllers in areas that would benefit through smart irrigation technologies.

- Lastly, some clusters are more receptive than others and these homeowners should be the primary audience of target marketing strategies. Specifically, the Proactive Consumer and Price-Sensitive Environmentalist clusters are the most receptive clusters to these technologies followed by the High-End Professionals. Target marketing would be more effective when aimed at these clusters. For instance:

    1. **Proactive Consumers** would likely be attracted by promotions emphasizing how smart irrigation systems provide short- and long-term benefits. They would also be receptive to information about irrigation system components that save water, such as sprinkler head types.

    2. **Price-Sensitive Environmentalists** would respond better to promotions addressing the environmental impacts of using smart irrigation controllers. Unlike the other clusters, this group is more price sensitive. Therefore, price promotions may be another means to encourage these consumers.

    3. **High-End Professionals** were the most interested in gaining knowledge about the actual irrigation system. Promotions emphasizing the sprinkler type, zones, efficiency, application rates, plants, water needs of plants, and soil type would appeal to this group the most.

CHAPTER-3

THEORITICAL ANALYSIS

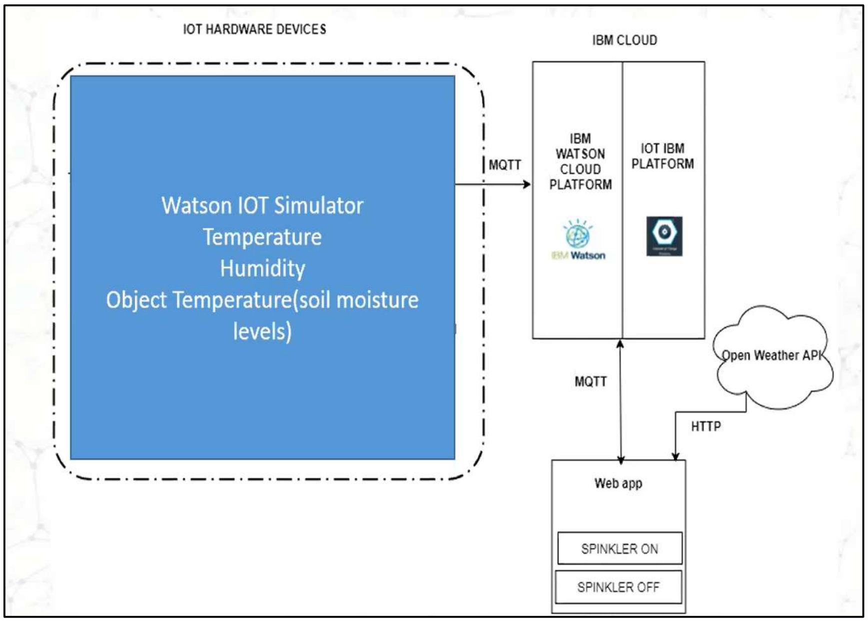
Uttar Pradesh agriculture's revenue occupies 12% of the total revenue of agriculture of India. At the same time, the agriculture in Uttar Pradesh consumes 80% of water usage of the state, not including some other water activities such as groundwater extraction which may potentially increase this figure to a higher level. The drought in Uttar Pradesh has lasted for years, which already causes huge economic loss to this market. Farmers have generally changed the types of crops which consumes less water to maintain their business. While if there is not an ultimate solution to increase the irrigation systems in Uttar Pradesh now, there is going to be a catastrophe on Uttar Pradesh's agriculture market.

Therefore, the idea was developed for this smart water irrigation system to save the water sustainability of the regional area, to maintain the crop fields environmental friendly by preventing soil and earth from getting flooded or dried, and, most importantly, to save economic cost of water usages for the farmers and for the whole market. While several different environmental factors play a key role in agricultural productivity, this project focuses purely on the water consumption aspects of agriculture.

The project is a scaled version, as much in size as in complexity, of what agricultural estates experience on a daily basis. Particularly, water system is a very crucial system for human society and the ongoing water shortage is the global and prevalent. With water being such a crucial focus of Uttar Pradesh's agriculture nowadays, several different water economization techniques and procedures have been put into practice already. Drip system irrigation is becoming more and more generalized and drought resistant crops are starting to replace too heavy water-consuming plants. However, following a study from the IIT, the method enabling the largest amount of water saving is through the installation of smart irrigation systems.

The modest crop shifting is able to save approximately 1.25 million acre-feet per year, the advanced irrigation management is able to save about the same amount of water and the efficient irrigation technology will also save around half a million acre-feet per year.

3.1 BLOCK DIAGRAM



In this project we will have to incorporate the hardware devices with the IBM Cloud. Here we will use the IBM Bluemix Simulator to send the data that the real device will be sending to the cloud. This transmission of the data will be through MQTT Protocol.

The IBM Cloud includes the IBM Watson Platform and IBM IoT Platform. Here we use Cloud because for a farmer or even a gardener it will be very important to not only get the current data but also the past data (preferably last 24 hours).

Furthermore, we also require the weather prediction as this device is placed in the agricultural

land. The idea of this device is to monitor the humidity and temperature in the agricultural land in addition to monitoring the state of the climate through the temperature of the weather and humidity.

All this data will be sent to the user's web application from where he can assess the situation and take further appropriate actions (like control of water motors). The data from IBM cloud will be sent via MQTT Protocol while that from Open Weather will be sent through HTTP protocol.

3.2 FOCUS OF THE STUDY

The focus of the smart water irrigation system, using the linear optimization designed, is to provide a comprehensive water delivering schedule which could both ensure that plants could have enough water for their growth and costs the minimum money for the water usage. The focus of the study is also trying to make all the information visual to the user and take in user defined input as new parameters into the linear optimization system. Before diving into the principles of optimization theory, it is important to understand the principles on which we built our model.

While the system is trying to use water wisely, it is not trying to reduce the amount of water used by the crops. Plants have specific water requirements in order to grow efficiently and in a productive way. Reducing water consumption by cutting productivity is opposite to the farmer's interest and shouldn't even be an eventuality. Hence, we focus on delivering water optimally in the sense that it will cost the farmer the least amount while avoiding any unnecessary loss of water.

The interesting theoretical assumption behind our model is that the price of water varies with the amount consumed. At peaks consumption times, the price is higher while water is cheapest at troughs. This is an analogy to the electricity supply network where cost varies directly with usage due to the input of multiple components of the energy mix such as renewable energy. In our case, cost of water is mainly decided by the farmers themselves since they represent 80% of the state's water consumption.

Most importantly, high water demands at specific times require large infrastructure with large dams, bigger canals and important water storage facilities to cope with this important variability.

Hence, if farmers adopt this optimization system, benefits are on both sides. The system should help the farmer use water at cheapest times, and hence save a considerable amount of money, while the water supplier benefits from this decrease in variability. Indeed, if our program incites to consume at troughs while avoiding peaks, the general consumption trend should be evened out and make the water supply more uniform over the day.

3.3 AUTOMATED IRRIGATION SYSTEM USING WSN AND GPRS MODULE

Automated Irrigation system using WSN and GPRS Module having main goal is that optimize use of water for agriculture crops. This system is composed of distributed wireless sensor network with soil moisture and temperature sensor in WSN. Gateway units are used to transfer data from sensor unit to base station, send command to actuator for irrigation control and manage data of sensor unit.

Algorithm used in system for controlling water quantity as per requirement and condition of filed. It is programmed in microcontroller and it sends command through actuator to control water quantity through valve unit. Whole system is powered by photovoltaic panels. Communication is duplex take place through cellular network. Web application manage the irrigation through continuous monitoring and irrigation scheduling programming. It can be done through web pages.

3.4 CROP MONITORING SYSTEM BASED ON WSN

The subsequent section introduces the Bluetooth technology. Wireless Sensor network crop monitoring application is useful to farmer for precision agriculture. The application monitors the whole farm from remote location using Internet of Things (IOT). Application works on sensor network and two types of nodes. Energy saving algorithm is used in node to save energy. Tree based protocol is used for data collection from node to base station.

System having two nodes one node that collect all environmental and soil parameter value and the other consist of camera to capture images and monitor crops. In this System Environmental change are not considered for sensor reading. System user is not able to program application. There is no controlling system for application.

3.5 AUTOMATIC DRIP IRRIGATION SYSTEM USING WSN AND DATA MINING ALGORITHM

Data mining algorithm are used to take decisions on drip irrigation system. Automated drip irrigation system having WSN placed in all over farm and different type of sensors. WSN uses ad hoc network which gives self-configuration and flexibility. Sensor data is given to base station and data is received using ZigBee. Data processing is done at base station for decision making. Data mining algorithm is used to take decision on data from sensor to drip. All observation is remotely monitor through web application.

This system works on Naïve Bayes algorithm for irrigation control. Algorithm works on previous data set for decision making if any attribute is not frequent result is zero.

Additionally, if the watering constraints are satisfied, the productivity of the crops will increase as the crops are in favourable growing conditions, while less water will be wasted by over-saturation and water percolation. The plant/water ratio is increased through this increase in productivity, which in the end is how a lot of water can be saved.

3.6 HARDWARE/SOFTWARE DESIGNING

3.6.1 IBM Cloud Platform

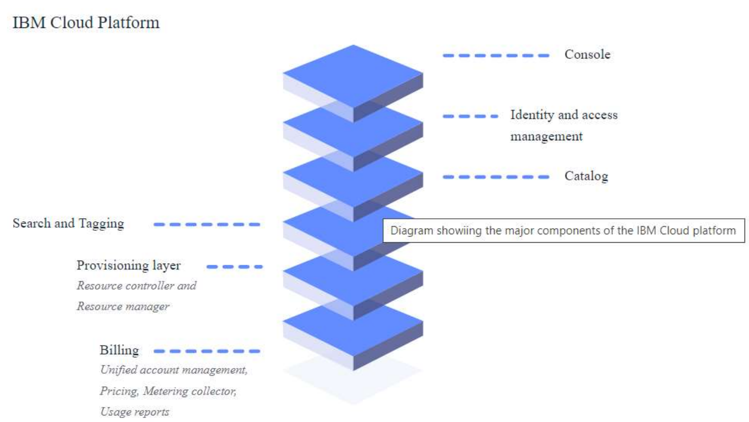
The IBM® cloud platform combines platform as a service (PaaS) with infrastructure as a service (IaaS) to provide an integrated experience. The platform scales and supports both small development teams and organizations, and large enterprise businesses. Globally deployed across data centres around the world, the solution you build on IBM Cloud™ spins up fast and performs reliably in a tested and supported environment you can trust.

The platform is built to support your needs whether it's working only in the public cloud or taking advantage of a multicloud deployment model.

Whether you need to migrate apps to the cloud, modernize your existing apps by using cloud services, ensure data resiliency against regional failure, or leverage new paradigms and deployment topologies to innovate and build your cloud-native apps, the platform's open architecture is built to accommodate your use case.

As the following diagram illustrates, the IBM Cloud platform is composed of multiple components that work together to provide a consistent and dependable cloud experience.

- A robust console that serves as the front end for creating, viewing, managing your cloud resources
- An identity and access management component that securely authenticates users for both platform services and controls access to resources consistently across IBM Cloud
- A catalog that consists of hundreds of supported products
- A search and tagging mechanism for filtering and identifying your resources
- An account and billing management system that provides exact usage for pricing plans and secure credit card fraud protection



IBM Cloud Catalog

IBM Cloud provides a full-stack, public cloud platform with a variety of products in the catalog, including compute, storage, and networking options, end-to-end developer solutions for app development, testing and deployment, security management services, traditional and open-source databases, and cloud-native services. You can find all of these services on the Services tab in the catalog. The lifecycle and operations of these services are the responsibility of IBM.

The Software tab includes a growing catalog of software products, including Cloud Packs, starter kits, Terraform-based templates, and Helm charts. Even though you're responsible for the lifecycle management, deployment, and configuration of these software products on your own compute resources, you can take advantage of a simplified installation process that helps you to get up and running quickly.

The catalog supports command-line interfaces (CLIs) and a RESTful API for users to retrieve information about existing products, and create, manage, and delete their resources.

Creating resources

The resource controller is the next-generation IBM Cloud platform provisioning layer that manages the lifecycle of IBM Cloud resources in your account. Resources are provisioned globally in an account scope. The resource controller supports both synchronous and asynchronous provisioning of resources. Examples of resources include databases, accounts, processors, memory, and storage limits.

Managing your resources

A collection of resources is managed by resource groups. A resource group is associated with your account. All IBM Cloud resources must be assigned to a resource group. When you create an account, a default resource group is created for you. All IBM Cloud IAM-enabled resources must be provisioned within a resource group. If you have a Lite account, you can have only one resource group. If you have a Pay-As-You-Go or Subscription account, you can create more than one resource group. If an account is suspended, the corresponding resource group is suspended as well, and all resources within the resource group are suspended.

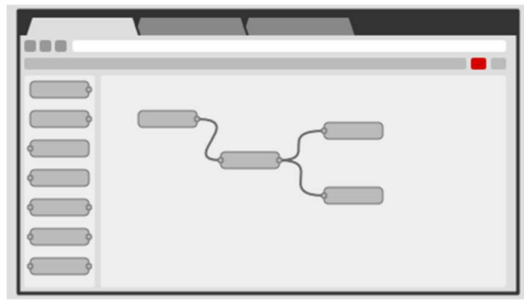
3.6.2 Node-RED

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 that makes it easy to wire together flows using the wide range of nodes in the palette that can be deployed to its runtime in a single-click.

Browser-based flow editing

Node-RED provides a browser-based flow editor that makes it easy to wire together flows using the wide range of nodes in the palette. Flows can be then deployed to the runtime in a single-click.

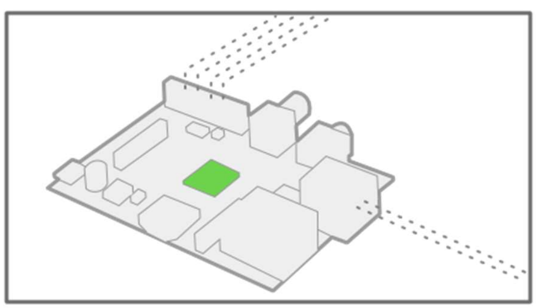


JavaScript functions can be created within the editor using a rich text editor.

A built-in library allows you to save useful functions, templates or flows for re-use.

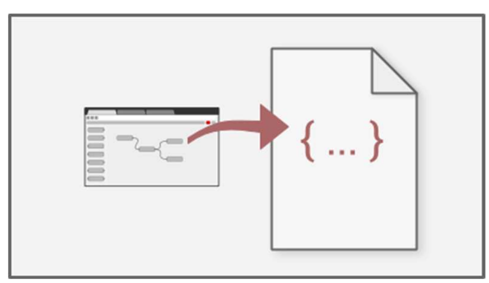
Built on Node.js

The light-weight runtime is built on Node.js, taking full advantage of its event-driven, non-blocking model. This makes it ideal to run at the edge of the network on low-cost hardware such as the Raspberry Pi as well as in the cloud.



With over 225,000 modules in Node's package repository, it is easy to extend the range of palette nodes to add new capabilities.

Social Development



The flows created in Node-RED are stored using JSON which can be easily imported and exported for sharing with others.

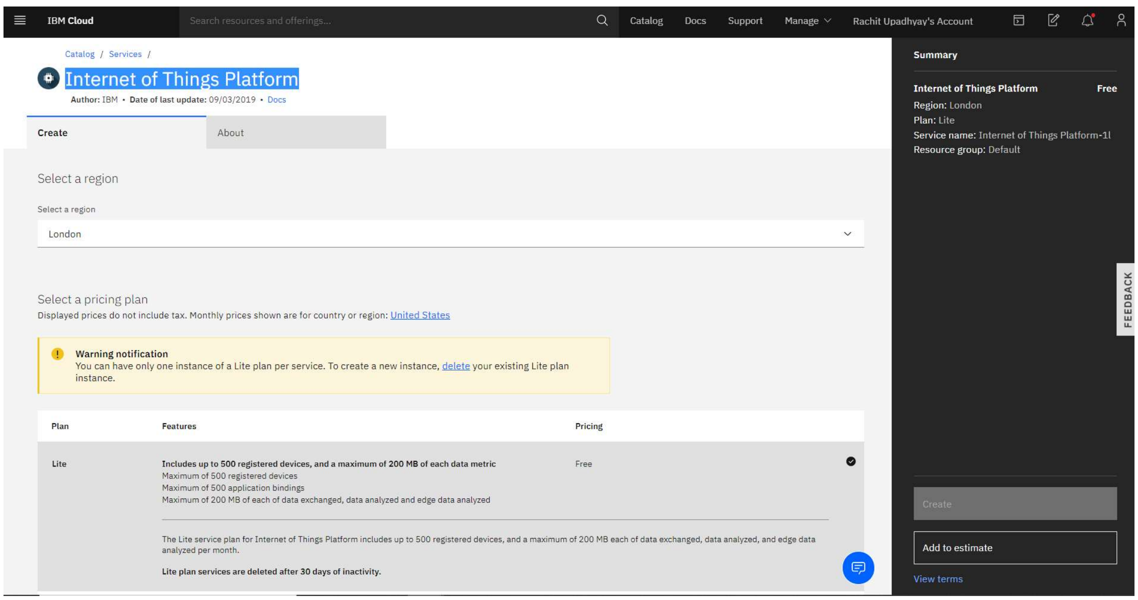
An online flow library allows you to share your best flows with the world.

CHAPTER-4

EXPERIMENTAL INVESTIGATION

4.1 IBM Cloud

The whole project is based on IBM Cloud service. First, I had to create an account in IBM Cloud. Then create the Internet of Things Platform Service from the catalog.

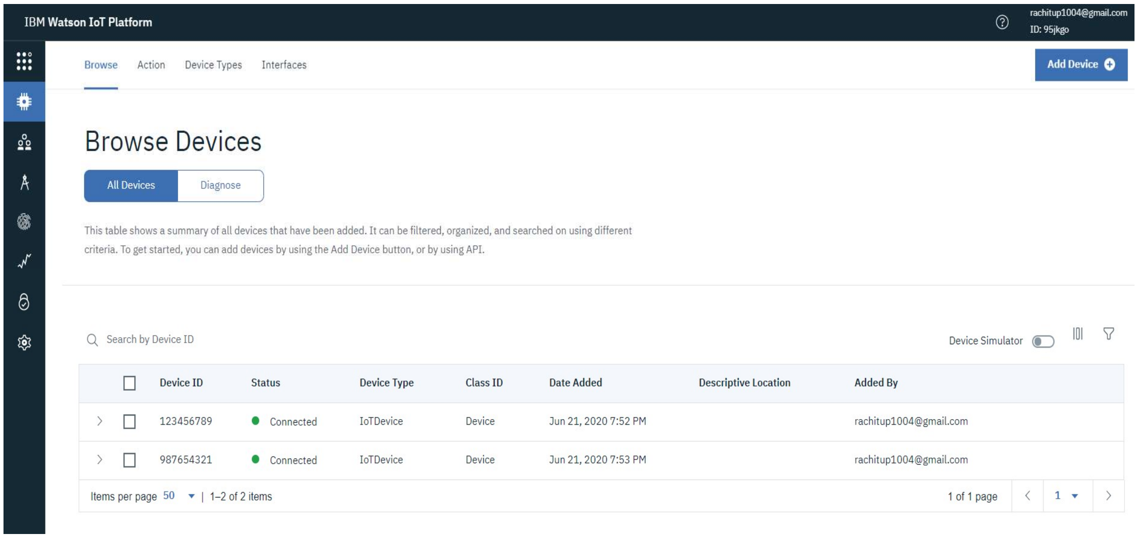


Launch the service after creating it.

After launching this service, it will redirect you to the IBM Watson IoT Platform. Where we will create the further devices that are actually provided to the farmer or the gardener. This will connect the hardware to the IBM Cloud and thus help us in keep the data in the cloud, where it can be accessed.

4.2 IBM IoT Platform

After launching the service from the IBM Cloud. It will redirect you to IBM Watson IoT Platform. Here we have to create couple of devices, one device will be for transmitting the data from sensor to the mobile application while other will be for receiving any command from the application.



Next, we have to create an API Key. An API key or ***application programming interface key*** is a code that gets passed in by computer applications. The program or application then calls the API or application programming interface to identify its user, developer or calling program to a website.

NOTE: You should also copy the API Key and auth-token along with the device identity.

4.3 Installing the Node-Red

❖ Install Node.js

Download the latest 10.x LTS version of Node.js from the official Node.js home page. It will offer you the best version for your system.

Run the downloaded MSI file. Installing Node.js requires local administrator rights; if you are not a local administrator, you will be prompted for an administrator password on install. Accept the defaults when installing. After installation completes, close any open command prompts and re-open to ensure new environment variables are picked up.

Once installed, open a command prompt and run the following command to ensure Node.js and npm are installed correctly.

Using cmd:

node --version && npm --version

You should receive back output that looks similar to:

v10.16.3

6.11.3

❖ Install Node-RED

Installing Node-RED as a global module adds the command node-red to your system path. Execute the following at the command prompt:

npm install -g --unsafe-perm node-red

❖ Run Node-RED

Once installed, you are ready to run Node-RED.

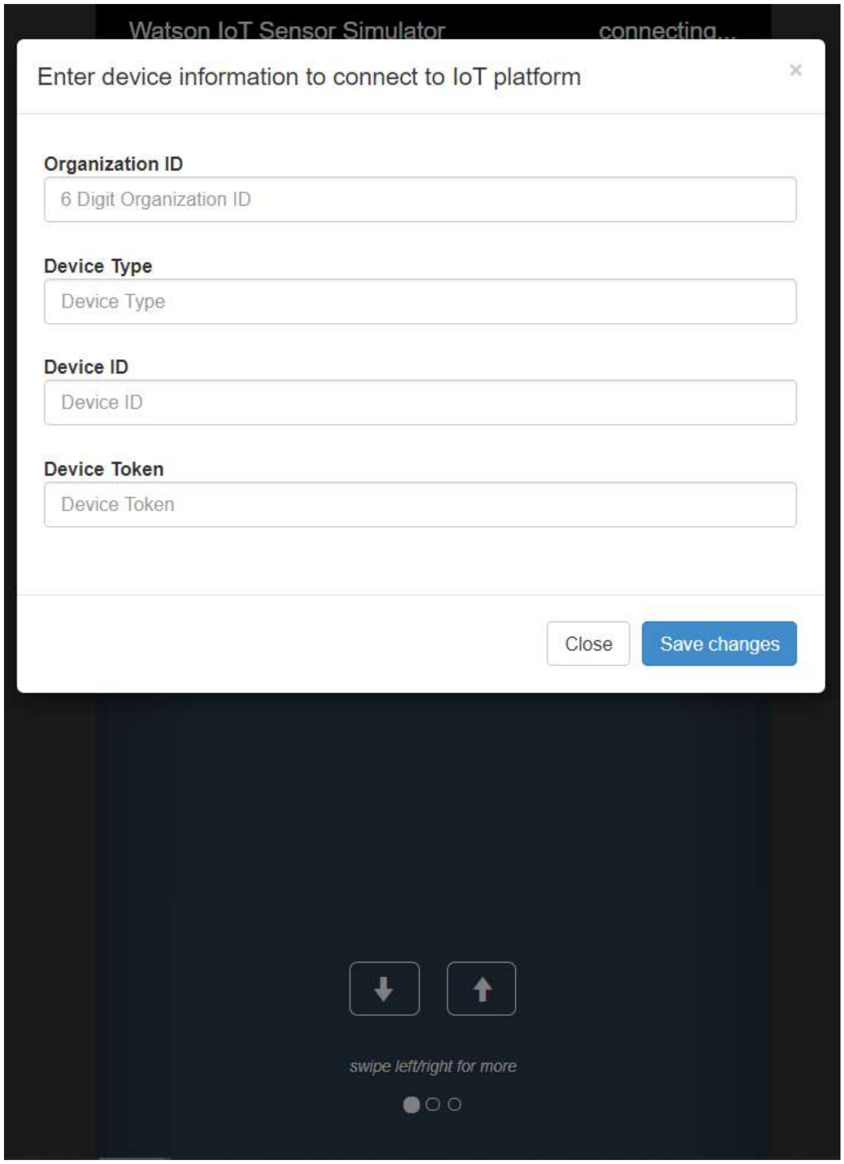
Use the command **node-red** in Node.js

4.4 Installing Python IDLE 3

The Python 3.8 series is the newest major release of the Python programming language, and it contains many new features and optimizations. It is available at Python's Official site. This is required to run the code for receiving the command from the mobile application.

4.5 Connecting the IoT Simulator to the Watson IoT platform.

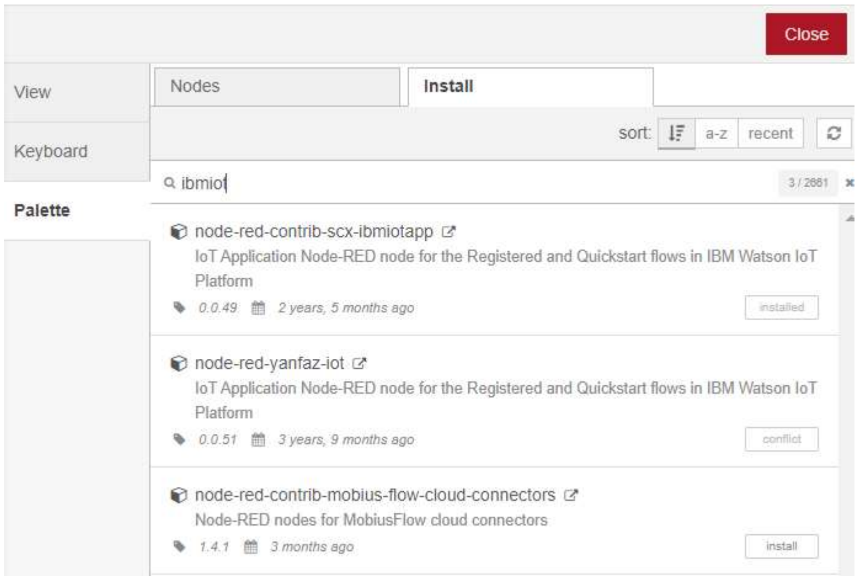
One of the devices created in the IBM Watson IoT Platform will have to receive the data from a sensor. I used the IBM's Bluemix IoT Sensor simulator and then I connected it to the device created in Watson IoT Platform.



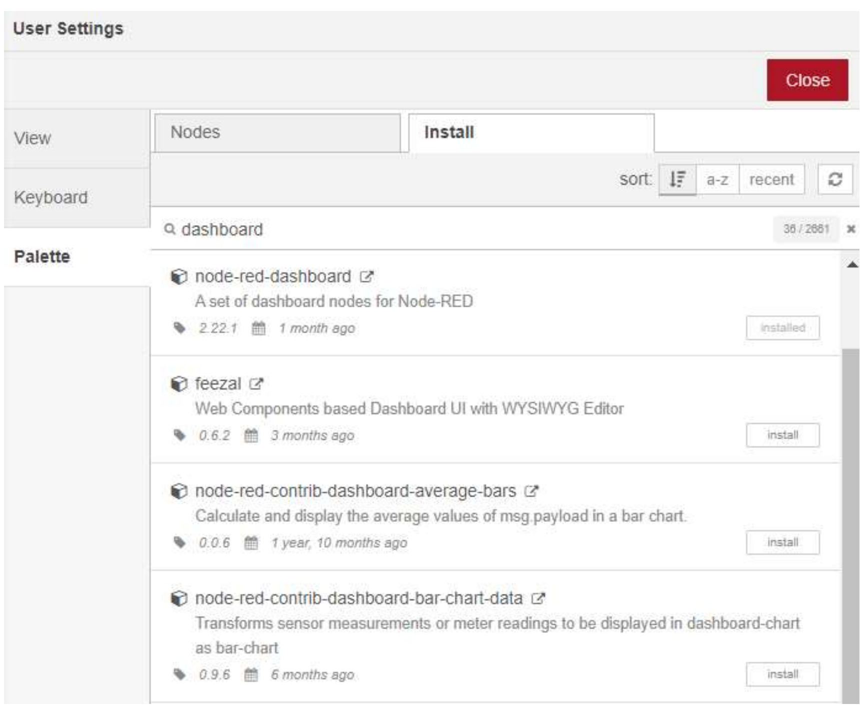
4.6 Creating a Node-red UI to view data in graphical form

To install IBM nodes in Node-red flow editor click on manage palette in the menu option which is on the top-right of the screen.

In install section search for ibmiot and install the ibm nodes to flow editor.

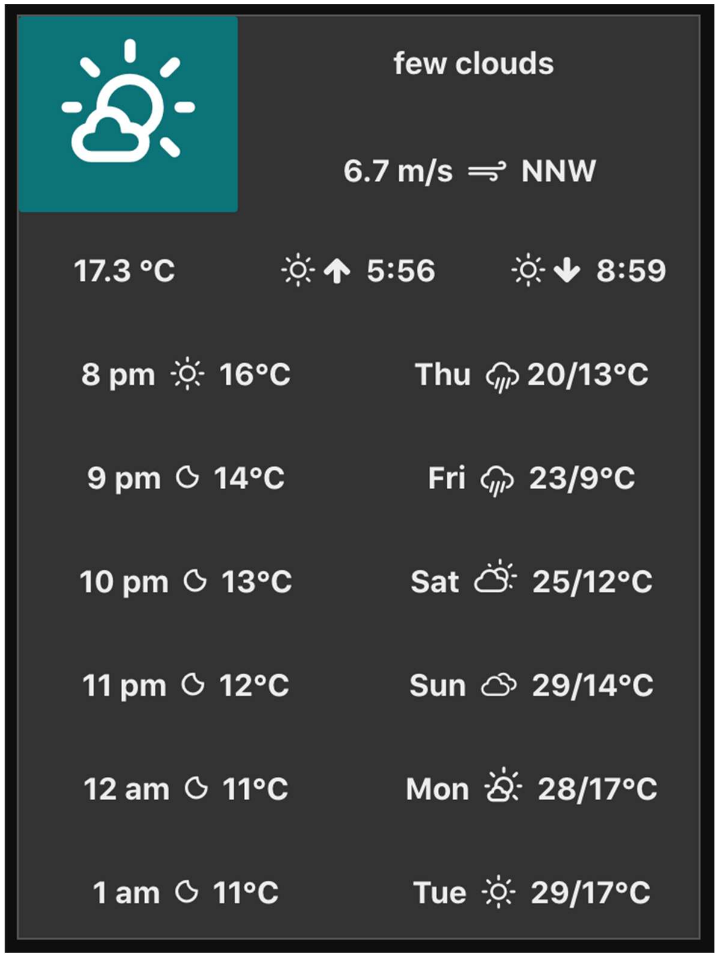


Further we need to install the dashboard nodes if they aren't installed already.



4.7 Building the Web Application

This flow pulls weather data from OpenWeatherMap (OWM) then presents it in a dashboard showing current weather conditions along with forecasts for the next 6 hours and 6 days. The mix of text and icons creates a compact and attractive display.



Moreover, there are also different tabs that shows the data pulled from the bluemix sensor. These are the temperature, humidity and the moisture level of the soil.

1. No Custom Nodes the OpenWeatherMap custom node is good but it doesn't use the new One Call API. So, I used standard nodes which was fairly easy. The HTTP call is simple and JSON data is returned which is perfect for Node-Red.

2. Weather Icons I used the "lite" set of weather icons which are now included in Node-Red. No need to install an icon set.

3. Setup and Configuration of Open Weather Map

4.8 Setup of Open Weather Map

Go to OpenWeatherMap and sign up for a free account to get an API key.

Open the node labelled "Set location, appid, units" in IBM IoT Dashboard flow and change these parameters:

- Change msg.payload.lat to your latitude.
- Change msg.payload.lon to your longitude.
- Change msg.payload.appid to your API key.
- Change msg.payload.units to imperial or metric.

NOTE: You can get your latitude and longitude by looking up your town in OpenWeatherMap.

- **One Call**

  I used the new One Call API from OpenWeatherMap that returns all this data:

  - Minute forecast for 1 hour
  - Hourly forecast for 48 hours
  - Daily forecast for 7 days
  - Historical data for 5 previous days

4.9 CODE FOR RECEIVING COMMANDS FOR MOTOR

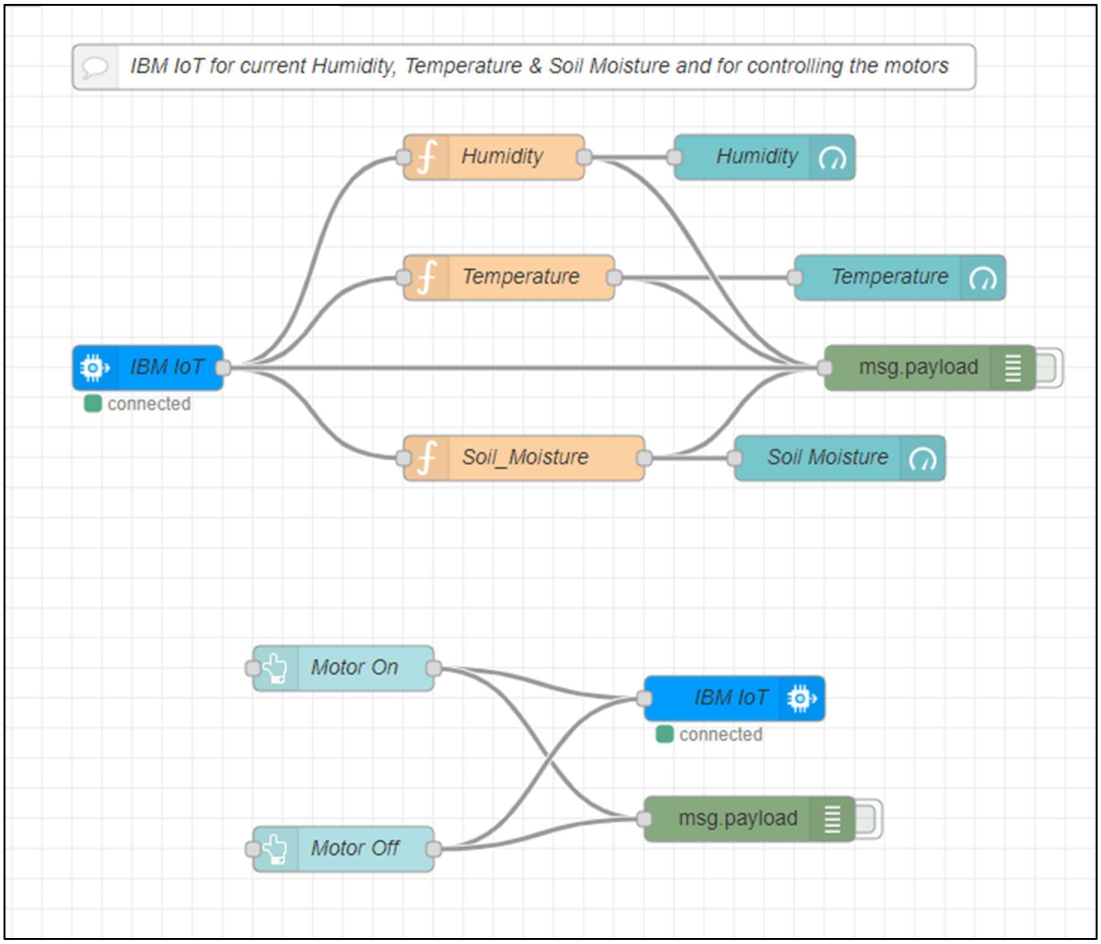
```
import time
import sys
import ibmiotf.application
import ibmiotf.device

#Provide your IBM Watson Device Credentials
organization = "95jkgo" #replace the ORG ID
deviceType = "IoTDevice"#replace the Device type wi
deviceId = "987654321"#replace Device ID
authMethod = "token"
authToken = "987654321" #Replace the authtoken
def myCommandCallback(cmd): # function for Callback
    print("Command received: %s" % cmd.data)
    if cmd.data['command']=='motoron':
        print("MOTOR ON IS RECEIVED")
    elif cmd.data['command']=='motoroff':
        print("MOTOR OFF IS RECEIVED")
    if cmd.command == "setInterval":
      if 'interval' not in cmd.data:
            print("Error - command is missing required information: 'interval'")
       else:
            interval = cmd.data['interval']
    elif cmd.command == "print":
        if 'message' not in cmd.data:
            print("Error - command is missing required information: 'message'")
        else:
            output=cmd.data['message']
            print(output)
```

```
try:
        deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMethod, "auth-token": authToken}
        deviceCli = ibmiotf.device.Client(deviceOptions)
        #..............................................
except Exception as e:
        print("Caught exception connecting device: %s" % str(e))
        sys.exit()

# Connect and send a datapoint "hello" with value "world" into the cloud as an event of type "greeting" 10 times
deviceCli.connect()
while True:
      deviceCli.commandCallback = myCommandCallback

# Disconnect the device and application from the cloud
```

CHAPTER-5

FLOWCHART

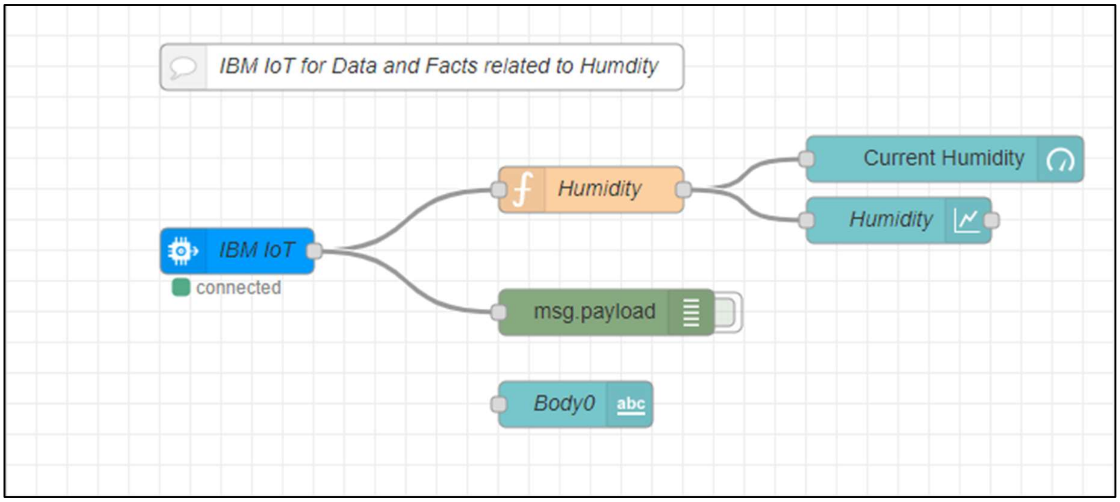
5.1 IBM IoT DASHBOARD



This is the main flow of the whole application. This flow displays the main dashboard where all the current reading (humidity, temperature and soil moisture) is transmitted. All this reading is shown in the gauge format. The readings are also in different colours, this help in the further visual display whenever the current reading goes out of range.

Furthermore, there is also the motor control on this main dashboard too, so whenever the reading goes beyond the required parameter it could be brought back in the ideal zone by turning the water motor on or off.

5.2 IBM IoT DASHBOARD FOR HUMIDITY



This is the flow which shows the current and all the past changes in the humidity. Here the farmer or the gardener can track down the change in the humidity of the area around where the plant is planted. This can help him/her in predicting the future changes and thus can help them in taking the necessary steps to overcome such changes.

These tracking of the humidity is done in two formats. First is the gauge format, which shows the current humidity of the area. While the second is in the form of line chart which shows the changes in the humidity over time.

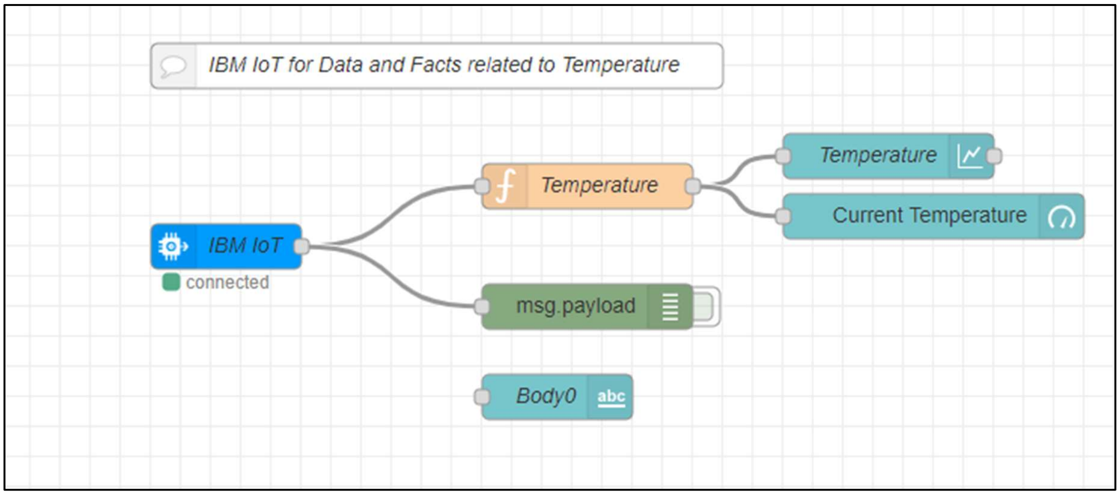
Also, this page shows some article about humidity. Like what is the appropriate amount of humidity that should be for a specific type of plant.

Note: *Setup and Configuration of IBM IoT*

Open the node labeled "IBM IoT" and change these parameters:

- *Change msg.applicationId to your API Key from the Watson IoT Platform*
- *Change msg.deviceType to your Device Type.*
- *Change msg.deviceId to your Device ID.*

5.3 IBM IoT DASHBOARD FOR TEMPERATURE



This is the flow which shows the current and all the past changes in the temperature. Here the farmer or the gardener can track down the change in the temperature of the area around where the plant is planted. This can help him/her in predicting the future changes and thus can help them in taking the necessary steps to overcome such changes.

These tracking of the humidity is done in two formats. First is the gauge format, which shows the current temperature of the area. While the second is in the form of line chart which shows the changes in the temperature over time.

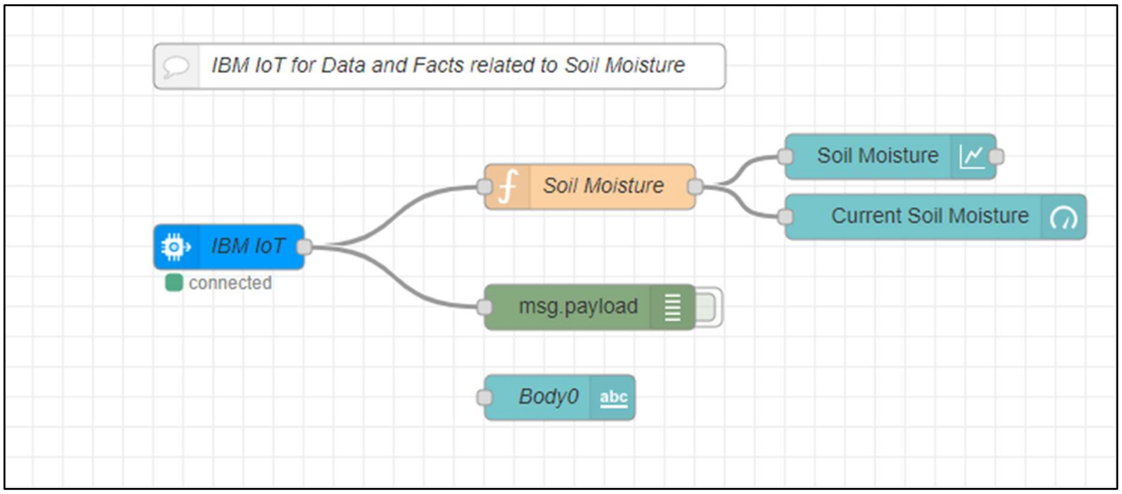
Also, this page shows some article about temperature. Like what is the appropriate amount of temperature that should be for a specific type of plant.

Note: *Setup and Configuration of IBM IoT*

Open the node labelled "IBM IoT" and change these parameters:

- *Change msg.applicationId to your API Key from the Watson IoT Platform*
- *Change msg.deviceType to your Device Type.*
- *Change msg.deviceId to your Device ID.*

5.4 IBM IoT DASHBOARD FOR SOIL MOISTURE



This is the flow which shows the current and all the past changes in the soil moisture. Here the farmer or the gardener can track down the change in the moisture of the soil around where the plant is planted. This can help him/her in predicting the future changes and thus can help them in taking the necessary steps to overcome such changes.

These tracking of the soil moisture is done in two formats. First is the gauge format, which shows the current moisture content of the area. While the second is in the form of line chart which shows the changes in the moisture over time.

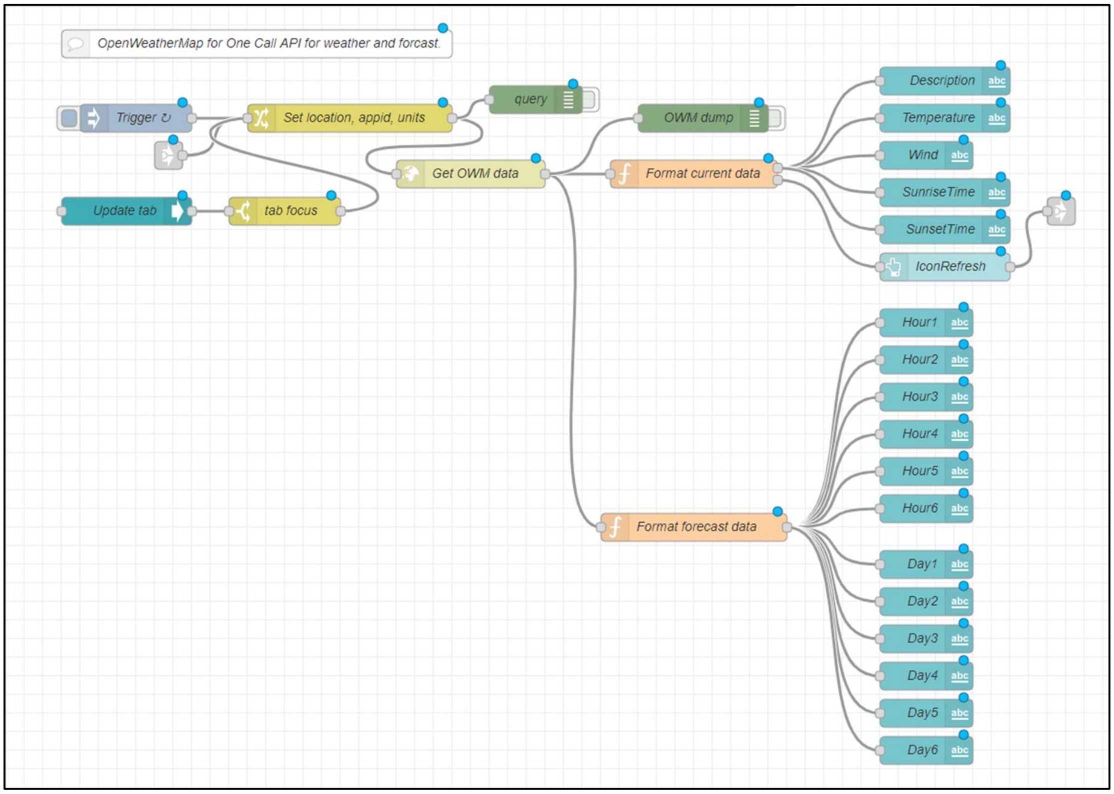
Also, this page shows some article about soil moisture. Like what is the appropriate amount of moisture level for a specific type of plant.

Note: *Setup and Configuration of IBM IoT*

Open the node labelled "IBM IoT" and change these parameters:

- *Change msg.applicationId to your API Key from the Watson IoT Platform*
- *Change msg.deviceType to your Device Type.*
- *Change msg.deviceId to your Device ID.*

5.5 OPEN WEATHER MAP FOR WEATHER AND FORECAST



This is the flow which shows the current weather and the forecast so that the farmer or the gardener can take the necessary steps and thus regulated the water supply and also check the plant status every sunrise or sunset.

This flow shows the current description of the weather along with an icon showing the weather condition along with current temperature. Further, this also shows the wind speed and the direction of the wind. Next it gives the forecast for the next six hours and the next six days which could be really good for a farmer or gardener.

The icon that shows the current weather condition also works as a refresh switch that refreshes the prediction.

Overall, this part could be a great asset to the professional farmer or even to an amateur gardener.

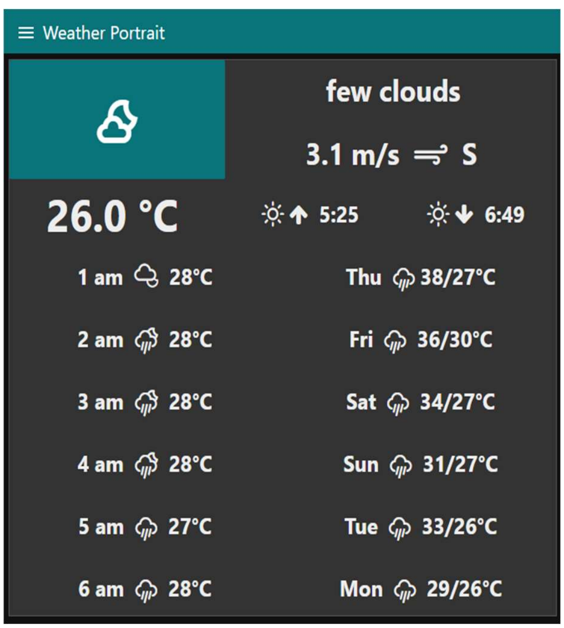
CHAPTER-6

RESULT

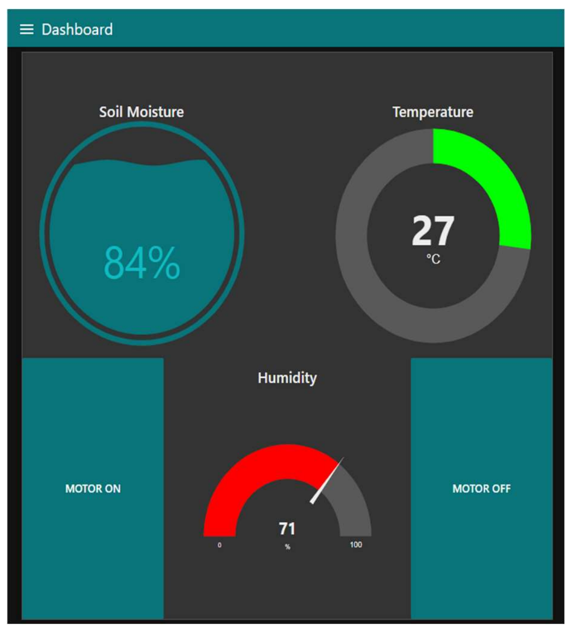
6.1 DELIVERABLES SOFTWARE

The Farmer or Gardener is provided a mobile app using which he/she can monitor the temperature, humidity and soil moisture along with weather forecasting details.

Along with these features they are also provided with dedicated space where they can track the history of the changes in the parameters such as temperature, humidity and soil moisture. Also, there are further articles on each of these parameters telling them what would be the appropriate amount of the range each of these parameters should be in.



Weather Forecast



Main Dashboard

6.2 DELIVERABLES HARDWARE

The Farmer or Gardener will also be provided couple of devices that has a dedicated Wi-Fi Module capable of connecting to internet, thus uploading the current condition of the area of the potted plant (Humidity, temperature and Soil Moisture) and also for controlling the water motors.

These device type should also be uploaded in the IBM Watson Platform in the device information column so that the MQTT Protocol rums smoothly.

The device should theoretically look something like this.

CHAPTER-7

ADVANTAGES & DISADVANTAGES

Smart irrigation systems offer a variety of advantages over traditional irrigation systems. Smart irrigation systems can optimize water levels based on things such as soil moisture and weather predictions. This is done with wireless moisture sensors that communicate with the smart irrigation controls and help inform the system whether or not the landscape is in need of water.

Additionally, the smart irrigation controlled receives local weather data that can help it determine when a landscape should be watered. If you have ever returned home during a storm only to see your sprinklers spraying water you know how beneficial this is. Rather than wasting water resources and your valuable money on watering your landscape you can take advantage of the nature moisture from the storm and save that water for another day when it is more needed. The advantages of these smart irrigation systems are wide reaching.

The smart irrigation system will help you have better control of your landscape and irrigation needs as well as peace of mind that the smart system can make decisions independently if you are away. You will save a significant amount of money on your water bills because through intelligent control and automation, your smart irrigation system will optimize resources so that everything gets what it needs without needless waste. Additionally, we have all seen many places in the country that have experienced droughts and we know that our water resources are precious.

With smart irrigation systems we can be better stewards of our resources which is better for the environment. The opportunity to save dramatically, have better control and be more eco-friendly while maintaining a lush and beautiful landscape are just a few of the advantages a smart irrigation system provides and would make a wonderful addition to any home.

The primary disadvantage associated with a smart irrigation is the expense. These systems can be quite costly depending on the size of the property. Furthermore, portions of the lawn will have to be dug up to install pipework and attach it to the plumbing system of the home. This can equate to days or weeks without use of the yard. Afterward, the landscaping will have to be repaired.

It is best to install an irrigation system before installing sod or extensive landscaping because some of it will have to be torn up. Homeowners who already have pristine yards may be turned off by this reality.

Even the most efficient smart systems can have their pitfalls. Wind can wreak havoc on sprinklers, directing water in the wrong direction. Underground pests may damage water-delivery systems, resulting in water pooling or broken parts. The repairs to fix an irrigation system can be much more costly than replacing a damaged garden hose.

7.1 ADVANTAGES

- Water motor can be controlled from long distances
- Economical design
- Can be implemented on large as well as small scale
- Can be used by everyone with basic knowledge of mobile app
- Smart irrigation systems can optimize water levels based on things such as weather predictions
- Increases efficiency and productivity
- Reduces soil erosion and nutrient leaching
- Save water

7.2 DISADVANTAGES

- Installation of the device is expensive
- The landscape would need to be destroyed while the piping is connected and hence can't use the field for that specific time period
- Wind speed can affect the sprinkler causing watering in wrong direction
- Underground pest may damage the piping
- Repairing is costly
- Requires 24x7 internet and electricity
- The risk of losing privacy i.e. the software can be hacked and misused
- Awareness of Indian farmer for this technology

CHAPTER-8

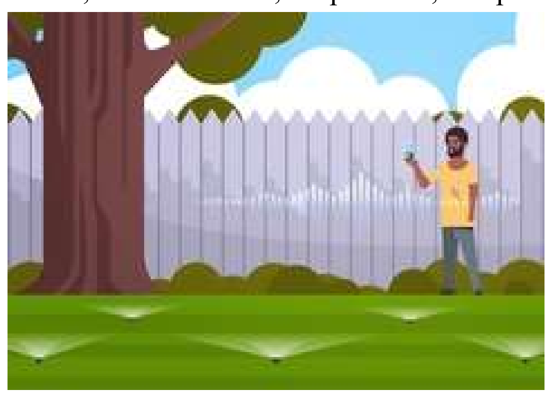
APPLICATIONS

8.1 The Future of Smart Irrigation Systems

In India, outdoor water uses alone averages more than 40 billion litres of water each day, mainly for landscape irrigation. As much as 50% of this water is wasted due to overwatering caused by inefficiencies in traditional irrigation methods and systems. Smart irrigation technology is the answer.

Smart irrigation systems tailor watering schedules and run times automatically to meet specific landscape needs. These controllers significantly improve outdoor water use efficiencies.

Unlike traditional irrigation controllers that operate on a pre-set programmed schedule and timers, smart irrigation controllers monitor weather, soil conditions, evaporation, and plant water use to automatically adjust the watering schedule to actual conditions of the site.



For example, as outdoor temperatures increase or rainfall decreases, smart irrigation controllers consider on site-specific variables, such as soil type, sprinklers' application rate, etc. to adjust the watering run times or schedules. There are several options for smart irrigation controllers.

The experts agree that smart irrigation systems and controllers versus traditional irrigation controllers conserve water across a variety of scenarios. Several controlled research studies indicate substantial water savings anywhere from 30 to 50 percent.

CHAPTER-9

CONCLUSION

To conclude the Farmer or Gardener is provided a mobile app using which he/she can monitor the temperature, humidity and soil moisture along with weather forecasting details.

Along with these features they are also provided with dedicated space where they can track the history of the changes in the parameters such as temperature, humidity and soil moisture. Also, there are further articles on each of these parameters telling them what would be the appropriate amount of the range each of these parameters should be in.

The experts agree that smart irrigation systems and controllers versus traditional irrigation controllers conserve water across a variety of scenarios. Several controlled research studies indicate substantial water savings anywhere from 30 to 50 percent.

CHAPTER-10

FUTURE SCOPE

In this project, the alerts go to the dashboard. That's nice for testing purposes, but obviously it is not good enough in production. In a production application, you would probably also use the IBM Push Notifications service for your alerts. With this service, you can send alerts by SMS. It also includes an API for writing alert applications for devices that do not have a cellular SMS number.

Another issue is dealing with multiple devices. The recent history chart automatically adjusts and shows multiple lines. Unfortunately, the gauges and alerts just rely on the latest information received. For the gauges, you can solve this by using a switch node and creating gauges for each.

We could use a similar approach with the alerts, but then we'd have to replicate a fairly complicated workflow. A better solution would be to replace the Report by Exception node with a node that keeps a list of devices and their latest statuses and identifies whenever the status of a specific device changes.

CHAPTER-11

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- https://thesmartbridge.com/documents/pdf/IoT-Device-Creation.pdf
- https://github.com/rachuriharish23/ibmsubscribe

APPENDIX

SOURCE CODE

https://github.com/SmartPracticeschool/llSPS-INT-2735-Smart-Agriculture-system-based-on-IoT/blob/master/Flow.json

This link provides the complete flow that has to be created in the Node-Red. Import this link in the Node-Red and then complete the further changes to setup the complete web application.

- Open the node labelled "Set location, appid, units" in IBM IoT Dashboard flow and change these parameters:
  - Change msg.payload.lat to your latitude.
  - Change msg.payload.lon to your longitude.
  - Change msg.payload.appid to your API key.
  - Change msg.payload.units to imperial or metric.
- Open the node labelled "IBM IoT" and change these parameters:
  - Change msg.applicationId to your API Key from the Watson IoT Platform
  - Change msg.deviceType to your Device Type.
  - Change msg.deviceId to your Device ID.