SMART AGRICULTURE SYSTEM BASED ON IoT

Project Report

1. ABSTRACT

Internet of Things (IoT) technology has brought revolution to each and every field of common man's life by making everything smart and intelligent. IoT refers to a network of things which make a self-configuring network. The development of Intelligent Smart Farming IoT based devices is day by day turning the face of agriculture production by not only enhancing it but also making it cost-effective and reducing wastage. The aim / objective of this report is to propose IoT based Smart Farming System assisting farmers in getting Live Data (Temperature, Soil Moisture) for efficient environment monitoring which will enable them to increase their overall yield and quality of products. In general the smart agriculture system based on IoT is can be created in various ways using arduino, physical development boards, and sensors and actuators.

Here we are creating a Web App which can be used by any farmer in user friendly way. The farmer is able to get the live updates of weather parameters such as temperature and humidity which are considered as major factors in farming field. Through this web app they can also able to operate motor i.e they can turn on or off the motor whenever required. The farmer can operate the motor without his presence in the field. This web app provides an advantage and can be utilized for farming in this growing technology and population. The additional benefit is the farmer can take precautions based on the weather parameters. In order to get the live data we will be using OpenWeatherApi and using HTTP protocol we can get the data.

2. INTRODUCTION

Farming is the backbone for the advancement of the nation. India is called as an Agricultural country for its remarkable agricultural lands and its other resources. In recent days, the temperature and soil moisture factors affect the growth of agriculture such as productivity, diseases, and yield production. Agriculture based issues has been the barrier for the development for the nation. There is a need for Modernization of the current standard techniques for Agriculture. New trends in Agriculture are required in managing crops in a controlled environment. Eg. Green houses.The Internet of Things is the recent advancement in the Internet field. The ideas facilitate to interconnect physical objects equipped with sensing, actuating, computing power by lending them the potential to collaborate on a task, by remaining connected to the internet, termed as the “Internet of things” IoT. With the assistance of detector, actuators and embedded microcontrollers the purpose of creating good object is accomplished. These good objects collect knowledge from the surroundings of development, process them, and initiate appropriate actions. Thus, the Internet of Things can bring wonderful support and helps humans in leading a wise and smart Agriculture. The importance and therefore the application of those technologies in the field of Agriculture has been studied and analyzed in this paper. With IoT, farmers will simply get a timely cultivating guideline relating to the parameters such as pesticide usage, seasonal plant diseases and additionally regarding natural disasters and recovery methods. Main advantage of synergizing agriculture with IoT, is elimination of human-to-human interaction and humanto-computer interaction.

Initially we should have to know about few topics to some extent in order to get a clear idea regarding the project "Smart agriculture system based on IoT". We should have to know about Internet of things, IBM cloud platform because using this platform here we are developing a Web App. Later under IBM cloud platform we have several features out of which here we are using node-red platform to build an UI(user interface) and we will be creating IoT device using IoT platform present in IBM cloud. Later we should know about the Watson simulator and its use and how it can be used and finally about the open weather API which gives the live data of city to any person remotely.

2.1 Internet of things:

Internet of things IOT consists of two words Internet and Things .The term things in IOT refers to various IOT devices having unique identities and have capabilities to perform remote sensing, actuating and live monitoring of certain sort of data. IOT devices are also enable to have live exchange of data with other connected devices and application either directly or indirectly , or collected data from other devices and process the data and send the data to various servers. The other term internet is define as Global communication Network connecting Trillions of computers across the planets enabling sharing of information .Thus the IOT can be define as :"A dynamic Global Network Infrastructure with self configuring capabilities based on standard and inter operable communication to protocol where physical and virtual things have identities, physical attributes ,and virtual personalities and use intelligent interfaces and are seamlessly integrated into the information network ,often communicate data associated with user and their environment." An ideal IoT device consists of various interfaces for making connectivity to other devices which can either be wired or wireless.

Any IoT based device consists of following components:

• I/O interface for Sensors.

• Interface for connecting to Internet.

• Interface for Memory and Storage.

• Interface for Audio/Video.

IoT devices can be of various forms like wearable sensors, smart watches, IoT smart home monitoring, IoT intelligent transport systems, IoT smart health devices etc. An IoT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data. The connectivity, networking and communication protocols used with these web-enabled devices largely depend on the specific IoT applications deployed.

IoT can also make use of artificial intelligence (AI) and machine learning to aid in making data collecting processes easier and more dynamic.

IMPORTANCE OF IOT: The internet of things helps people live and work smarter, as well as gain complete control over their lives. In addition to offering smart devices to automate homes, IoT is essential to business. IoT provides businesses with a real-time look into how their systems really work, delivering insights into everything from the performance of machines to supply chain and logistics operations. IoT enables companies to automate processes and reduce labour costs. It also cuts down on waste and improves service delivery, making it less expensive to manufacture and deliver goods, as well as offering transparency into customer transactions. As such, IoT is one of the most important technologies of everyday life, and it will continue to pick up steam as more businesses realize the potential of connected devices to keep them competitive

PROS AND CONS OF IoT:

Some of the advantages of IoT include the following: ability to access information from anywhere at any time on any device;

- improved communication between connected electronic devices;
- transferring data packets over a connected network saving time and money; and
- automating tasks helping to improve the quality of a business's services and reducing the need for human intervention.

Some disadvantages of IoT include the following:

- As the number of connected devices increases and more information is shared between devices, the potential that a hacker could steal confidential information also increases.
- Enterprises may eventually have to deal with massive numbers -- maybe even millions -- of IoT devices, and collecting and managing the data from all those devices will be challenging.
- If there's a bug in the system, it's likely that every connected device will become corrupted.

- Since there's no international standard of compatibility for IoT, it's difficult for devices from different manufacturers to communicate with each other.

Applications of IOT in smart agriculture:

Although the use of smart agriculture is not popular in India, still it shows dynamic capabilities for supporting agriculture. It supports the plant growth and development in many ways. Some of such applications are listed below to enhance plant growth:

Monitoring of Climate Conditions Climate and weather conditions are the primary factors to be noted during agriculture. Smart agriculture using IoT makes use of several sensors for monitoring the climate conditions of the surroundings. the task of the sensor is to collect the data across the field send it to the cloud. the cloud is loaded with some basic measurements which will then be compared with the sensed data. Based on the comparison, we will be able to map the climatic conditions and choose the required crop for cultivation. Some examples of such agriculture IoT devices are all METEO, Smart Elements, and Pycno.

Agriculture Drones: One of the best applications of IoT in agriculture are Drones. Drones provide pictorial and aerial maps about the plants, thus making the farmer understand that which crop is in need of immediate attention. Drones also evaluate the health state, irrigation, monitoring of progress, spraying, and planting of each crop. Drones are helpful in saving time and effort. the drones are comprised of two types: ground-based and aerial based drones. Both are used for crop health assessment, irrigation, planting, and soil & field analysis. Farmers have to choose the height or ground resolution of the field for which the Drones have to be used. Then the Drones take the pictures of the crops and helps the farmer to give immediate assistance for the required crops.

Crop Water Management: Water is the essential resource for performing agriculture. All the agricultural activities are based on the adequate supply of water. Hence it is necessary for the farmer to ensure adequate supply of water to the crops. This technique uses the Web Map Service (WMS) and Sensor Observation Service (SOS) for ensuring proper water supply for the irrigation of the crops. Thus this IoT reduces water wastage.

Smart Greenhouses: Greenhouse farming is a technique that boosts the yield of crops, vegetables, fruits etc., Environmental parameters are controlled by Greenhouses in two ways; either through manual intervention or a proportional control mechanism. However, since

manual intervention has disadvantages such as production loss, energy loss, and labour cost, these methods are less effective. A smart greenhouse through IoT embedded systems not only monitors intelligently but also controls the climate. Thereby eliminating any need for human intervention. Different sensors that measure the environmental parameters according to the plant requirement are used for controlling the environment in a smart greenhouse. Then, a cloud server creates for remotely accessing the system when it connects using IoT.

2.2 Cloud Computing

Cloud computing is the buzzword today in the IT world. The most appropriate definition of cloud computing is provided by Borko Furht of Florida Atlantic University, who defines it as "a new style of computing in which dynamically scalable and often virtualised resources are provided as a service over the Internet." The integration of IOT and cloud computing is of great significance. Cloud computing powerful storage, processing and service ability, combined with the IOT's ability of information collection, composes a real network between people and items and the items themselves. Cloud computing is a computing paradigm, where a large pool of systems are connected in private or public networks, to provide dynamically scalable infrastructure for application, data and file storage. With the advent of this technology, the cost of computation, application hosting, content storage and delivery is reduced significantly. Cloud computing is a practical approach to experience direct cost benefits and it has the potential to transform a data center from a capital-intensive set up to a variable priced environment. The idea of cloud computing is based on a very fundamental principal of reusability of IT capabilities'. The difference that cloud computing brings compared to traditional concepts of "grid computing", "distributed computing", "utility computing", or "autonomic computing" is to broaden horizons across organizational boundaries. Despite differences in defining Cloud computing, there is at least a common understanding that a layered architecture exists. The number of layers is not fixed and the foundation is versatile hardware. The lowest layer comprises the hardware, on top of that comes the software platform and on top of which is built the software layer. All these layers expose their functionality to the layer above as a service via well defined APIs. These layers are called, starting from the lowermost layer, Infrastructure-as-aService (IAAS), Platform-as-a-Service (PAAS) and Software-as-a-Service (SAAS). Data is one of the most important components of this stack and providing data as service has a huge potential, especially to the geospatial world. Data as a Service (DAAS) is less talked about compared to the above mentioned layers. As many vendors

are now offering cloud based services in one or all of these layers and since the research community is keen to utilize the potential of the cloud, the importance of data availability as a service is of great interest, especially for geographical data. The concept of DAAS is to provide valuable data as a service over the internet on a pay per use basis.

2.3 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 multi-cloud deployment model. With our open-source technologies, such as Kubernetes, Red Hat OpenShift, and a full range of compute options, including virtual machines, containers, bare metal, and serverless, you have as much control and flexibility as you need to support workloads in your hybrid environment. You can deploy cloud-native apps while also ensuring workload portability. 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.

2.4 Node-Red

Node-RED is a flow-based programming tool, originally developed by IBM’s Emerging Technology Services team and now a part of the JS Foundation. Invented by J. Paul Morrison in the 1970s, flow-based programming is a way of describing an application’s behaviour as a network of black-boxes, or “nodes” as they are called in Node-RED. Each node has a well-defined purpose; it is given some data, it does something with that data and then it passes that data on. The network is responsible for the flow of data between the nodes. It is a model that lends itself very well to a visual representation and makes it more accessible to a wider range of users. If someone can break down a problem into discrete steps they can look at a flow and get a sense of what it is doing; without having to understand the individual lines of code within each node. Node-RED consists of a Node.js based runtime that you point a web browser at to access the flow editor. Within the browser you create your application by dragging nodes from

your palette into a workspace and start to wire them together. With a single click, the application is deployed back to the runtime where it is run. The palette of nodes can be easily extended by installing new nodes created by the community and the flows you create can be easily shared as JSON files.

2.5 OpenWeatherMap API

OpenWeatherMap is one of the leading digital weather information providers. It is a small IT company, established in 2014 by a group of engineers and experts in Big Data, data processing, and satellite imagery processing. The headquarters is in the UK, office is established in the USA, and the development team in Latvia (EU).

OpenWeatherMap provides the following advantages to the users

- **Weather data is open:** current weather, forecasts, maps with precipitations, wind, clouds, data from weather stations are available through APIs, maps and other products.
- **Coverage is global:** weather data is available for any geographic location.
- **Weather model:** own model of weather forecast calculation, WRF model for regions + global models.
- **Advanced technologies for a competitive price:** due to Big Data technology costs of production and support are cheap, a price for a user is affordable.

The OpenWeatherMap service provides a Current Weather API, along with several types of forecasts with different depths and measurement steps:

- Minute Forecast – for 1 hour
- Hourly Forecast – for 4 days
- 3-hour Step Forecast – for 5 days
- Daily Forecast – for 16 days
- Climate Forecast – for 30 days

2.6 HTTP PROTOCOL

The Hypertext Transfer Protocol (HTTP) is an application-level protocol for distributed, collaborative, hypermedia information systems. This is the foundation for data communication for the World Wide Web (i.e. internet) since 1990. HTTP is a generic and stateless protocol which can be used for other purposes as well using extensions of its request methods, error codes, and headers.Basically, HTTP is a TCP/IP based communication protocol, that is used to deliver data (HTML files, image files, query results, etc.) on the World Wide Web. The default port is TCP 80, but other ports can be used as well. It provides a standardized way for computers to communicate with each other. HTTP specification specifies how clients' request data will be constructed and sent to the server, and how the servers respond to these requests.

There are three basic features that make HTTP a simple but powerful protocol:

- **HTTP is connectionless:** The HTTP client, i.e., a browser initiates an HTTP request and after a request is made, the client waits for the response. The server processes the request and sends a response back after which client disconnect the connection. So client and server knows about each other during current request and response only. Further requests are made on new connection like client and server are new to each other.
- **HTTP is media independent:** It means, any type of data can be sent by HTTP as long as both the client and the server know how to handle the data content. It is required for the client as well as the server to specify the content type using appropriate MIME-type.
- **HTTP is stateless:** As mentioned above, HTTP is connectionless and it is a direct result of HTTP being a stateless protocol. The server and client are aware of each other only during a current request. Afterwards, both of them forget about each other. Due to this nature of the protocol, neither the client nor the browser can retain information between different requests across the web pages.

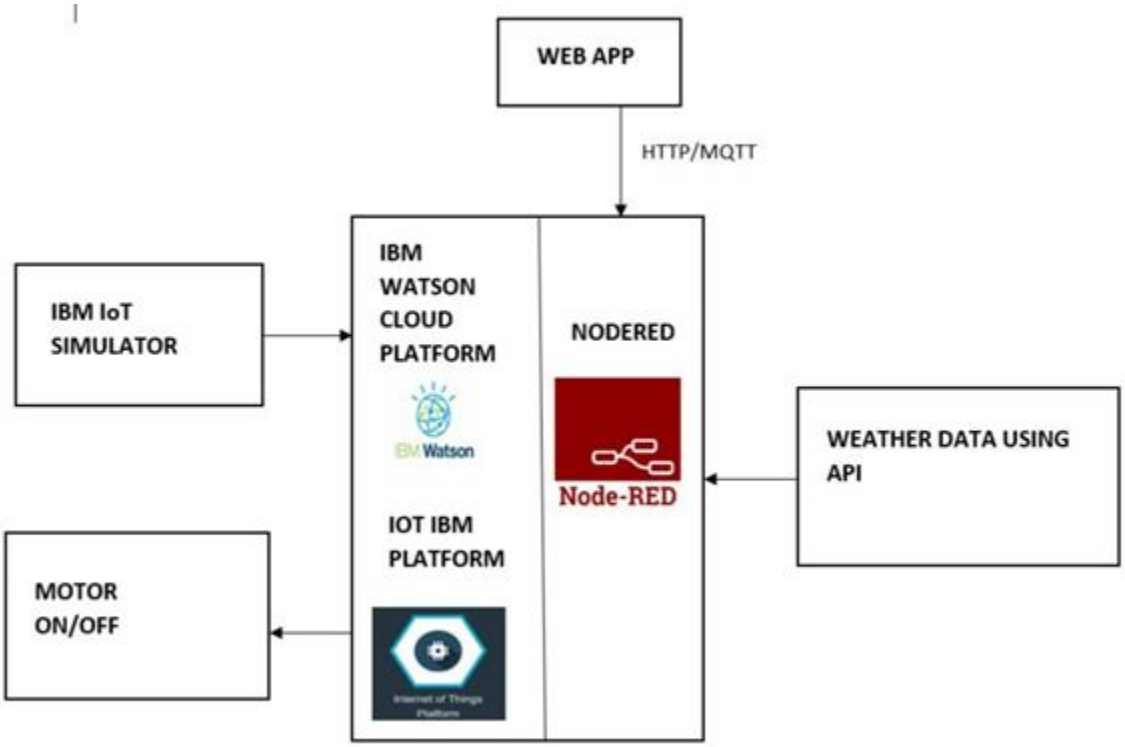
3. OVERVIEW OF PROJECT

Agriculture is the major sector of any country in the world because no human in the world can live without food. In present scenario when we consider the farming system of India it is strategically utilized based on the type of soil and the season and considering various factors in order to farm the land. Where as in earlier days farmers used to figure out the ripeness soil and influenced suspicions to develop which to kind of yield. They won't bother regarding humidity, climatic conditions and water level. Most probably we should have to consider the amount of micro and macro nutrient and various chemicals while farming in order to have an healthy lifestyle. In such a scenario where we should have to consider all the factors IOT(Internet of things) plays an important role by empowering the agriculturists through various strategies like accuracy practicing farming to deal with challenges in the field. The main idea and the scope of the project is to create a smart agriculture system which is easy to use and accurately gives the information regarding various factors that are required to farm the land remotely. The project uses IBM cloud for various services, platform and for node_red. Internet of Things is an emerging topic of technical, social, and economic significance. Consumer products, durable goods, cars and trucks, industrial and utility components, sensors, and other everyday objects are being combined with Internet connectivity and powerful data analytic capabilities that promise to transform the way we work, live, and play.

Here the main aim of the project is to create a Web App which is user friendly and is useful for the farmers in a unique way. The UI created here will display the details like temperature, humidity, object temperature using Watson IoT simulator, basically an IoT device is generated using IBM IoT platform and details is being displayed. Later on using open weather api weather details of any city can be found and here using http protocol the weather details is be extracted and displayed on UI which is being created earlier. The UI created is transformed in such a way that it provides a buttons for Motor on/off. The farmer can on or off the motor whenever it is required here as it is a Web App we are using a python code which displays the status of the motor. This can be further developed by adding some other features like moisture content, detecting the micro/macro nutrients of soil and help the farmer to know regarding what to be done under insufficient nutrients value.

IoT based SMART FARMING SYSTEM is regarded as IoT gadget focusing on Live Monitoring of Environmental data in terms of Temperature, Moisture and other types depending on the sensors integrated with it. The system provides the concept of "Plug & Sense" in which farmers can directly implement smart farming by as such putting the System on the field and getting Live Data feeds on various devices like Smart Phones, Tablets etc. and the data generated via sensors can be easily shared and viewed by agriculture consultants anywhere remotely via Cloud Computing technology integration. The system also enables analysis of various sorts of data via Big Data Analytics from time to time.

3.1 Block diagram



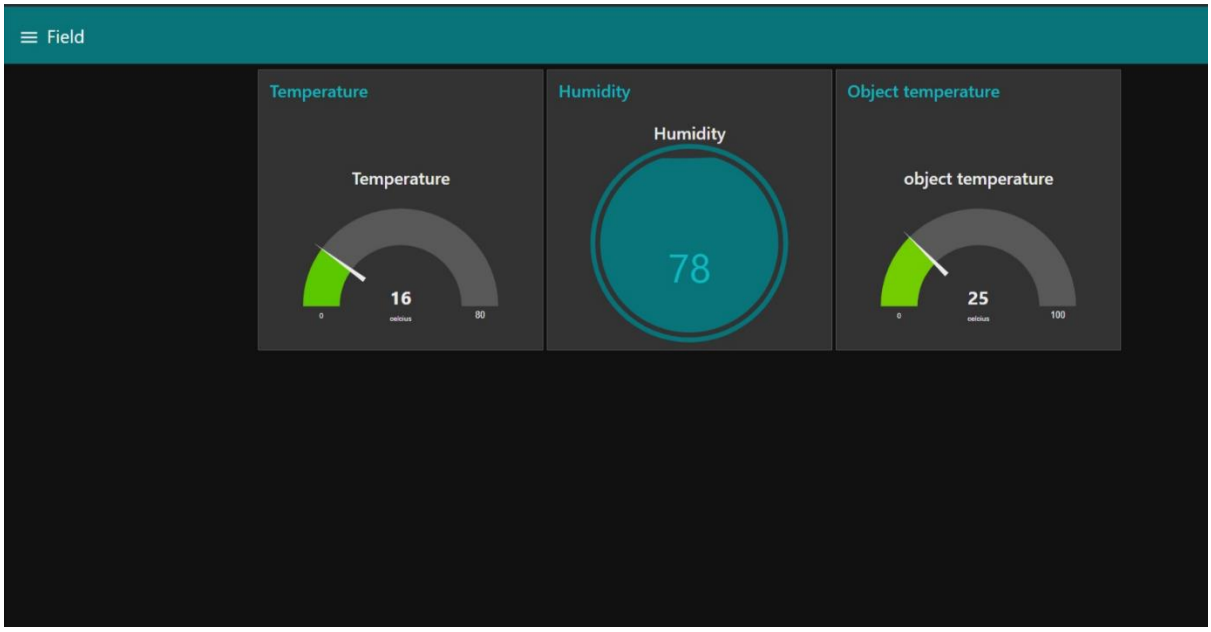
In the above block diagram can be taken as a reference in order to complete the project. Here it can be explained as initially we will be creating a device using IoT IBM platform and device credentials is to be saved for the further use, later we will connect the device to Watson IoT simulator using the device credentials. Now we should have to install the required IBM IoT node in our node-red flow later on we should have to configures the nodes in such a way that we should have to get the simulator data in the UI which has been created. The next step to be

followed is we should have to check that our device is properly connected or not in IoT platform, later we should have to create an account in OpenWeatherMaps and should have to generate API key and should have to get the weather data of any city of our preference. After getting the data, in node-red flow we should have to configure nodes and here we will be using HTTP protocol to retrieve the data. Now we are ready to display simulator data and live weather data of a city. The next step to be followed is to creating buttons which are used to control the motor. The motor status command to be displayed in the UI by setting the required notes, next we will be writing a python code where it displays the motor command which is being pressed by the user.

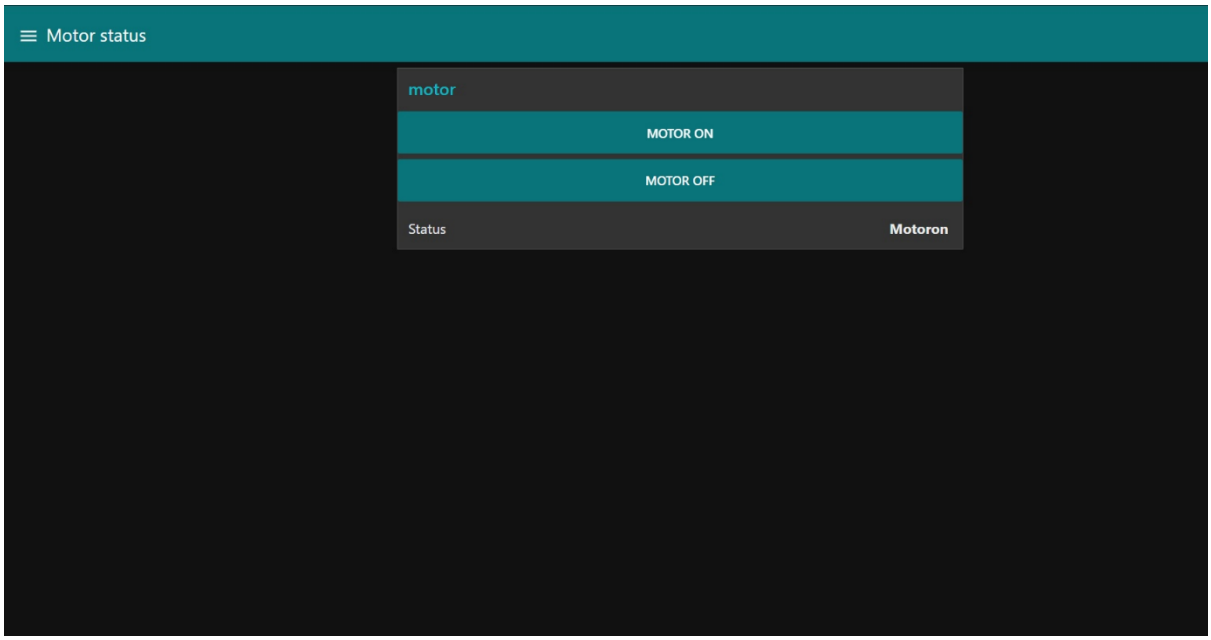
4. RESULTS

The below pictures indicate the results obtained after completing all the steps

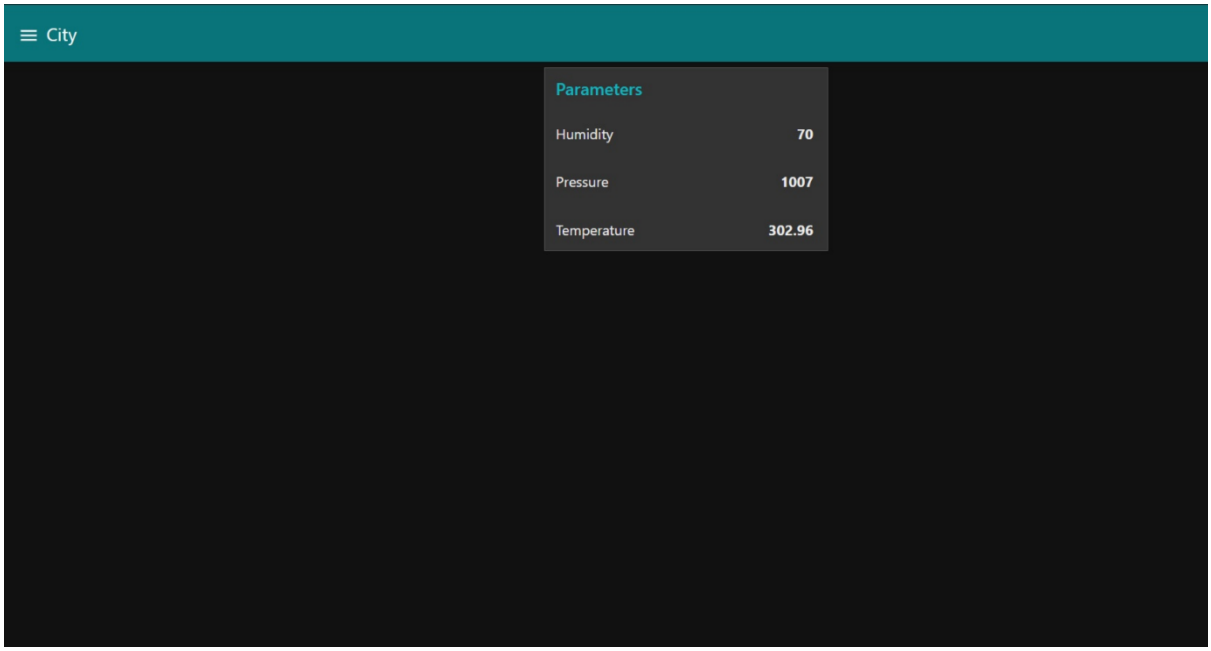
1. Below shows the details which are obtained from IoT simulator



2. It displays the motor button and its status



3. The below figure shows the parameters obtained from OpenWeatherMap



4. Below shows the commands received when we run the python code

5. CONCLUSION

IoT based SMART FARMING SYSTEM for Live Monitoring of Temperature and Humidity has been proposed using Cloud Computing . The System has high efficiency and accuracy in fetching the live data of temperature and soil moisture. The IoT based smart farming System being proposed via this report will assist farmers in increasing the agriculture yield and take efficient care of food production as the System will always provide helping hand to farmers for getting accurate live feed of environmental temperature and soil moisture with more than 99% accurate results.

6. FUTURESCOPE

Future work would be focused more on increasing other features on this system to fetch more data especially with regard to Pest Control and by also integrating GPS module in this system to enhance this Agriculture IoT Technology to full-fledged Agriculture Precision ready product. we can also add some external features like we can find the soil nutrients contents and help the farm to yield a better crop.