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SMART WEATHER AND SOIL REPORT

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ABSTRACT

This paper proposes a weather and soil monitoring system which collects the various data about surrounding weather and soil. The proposed system is based on NodeMCU and it gives values of temperature, humidity and soil moisture with the help of various sensors present in the system.These sensors sense the instance values of temperature,humidity and soil moisture and gives the data it to the controller.This controller sends the data to web page using cloud as its interface. The data uploaded to the web page can easily be accessible from anywhere in the world. The data gathered in these web pages can also be used for future references. The project even consists of an app with a name called "Weather and Soil monitoring" that has current data of temperature, humidity and soil moisture . This app also sends messages as an effective alert system to warn people about low moisture levels of soil and asks them to water the plants. This project can be of great use to farmers.

Keywords: Internet of Things,Node MCU,Sensors,Node-RED,Mobile.

I. INTRODUCTION

Internet of things (IOT) term represents a general concept for the ability of network devices to sense and collect data from around the world and then, share that data across the internet, where it can be processed and utilized for various interesting purposes. Now-a-days everyone is connected with each other using lots of communication way. Internet of things can also be defined as the collection of two terms: one is internet,which is defined as networks of networks which can connect billion of users with some standard internet protocols. Internet connects several different sectors and department while using different technologies. Several devices like mobile, personal systems and business organizations are connected to internet. The second term is thing, this term is basically mean to these devices or objects which turn into intelligent objects.Now-A-Days everywhere like, at railway station, shopping malls, in colleges an information desk is mandatory that provides information about the train schedule, promotional offers and important notice immediately. The best tool is cell phone, which are available to almost everyone and that is connectable to internet to download latest information. The essential idea of the IOT has been around for nearly two decades, and has attracted many researches and industries because of its great estimated impact in improving our daily lives and society.

Due to globalization and population growth this figure of water conservation has been increasing every year. So it became a major challenge to every nation for reducing the farm water consumption. For better irrigation system, it is very crucial to measure the soil moisture for agriculture application, so that it will help farmers to manage their farm land more effectively. The invent of IOT would discover the new ways that put full potential of agriculture yield and mitigate the challenges that hinders the growth of crops. With the IOT, the monitoring of weather forecast,temperature and humidity, soil moisture level could be connected and information gathered from the sensors is sent to the farmers through mobile phones. To determine the soil moisture we have designed and developed a nickel probes based soil moisture sensor and a response monitoring system. By knowing the moisture value, we can estimate when to water and how much to water the fields so that there is no over-watering or wilting of crops. These practices will increase crop yield, improve quality of crops, conserve water resources, save energy.Weather is an important criteria on which growth of plants depend on.Unnatural weather conditions can cause production losses,specifically if experienced during the crucial levels of growth.The integration technology with agriculture can increase the quality,productivity and reduces the environmental effect on crop.This is possible with the help of Internet of Things.

IOT is divided into three layers.They are sensor layer,network layer and application layer.Sensor layer is created from different sensors like dht sensor,soil moisture sensor etc.Network layer is created from different

structures of networks,together with cloud platforms and the internet.Application layer consists of the interface for clients and the device.In this project in the sensor layer we used DHT11 and soil moisture sensors.In the network layer we used IBM cloud and internet .In the application layer we created an android app and its act as an interface between client and device.

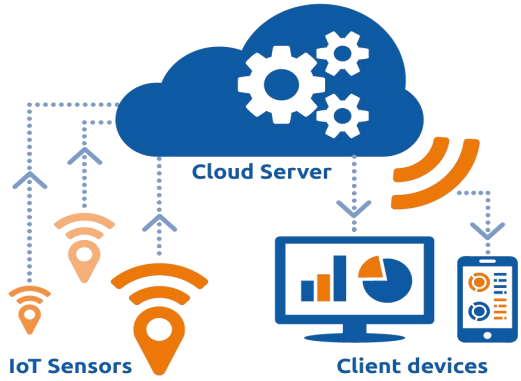

Figure 1 : layer diagram

ORGANIZATION OF THESIS
I.Introduction
II.Literature Survey
III.Proposed IOT model
i . hardware
ii . software
iii . web application
iv . mobile application
IV.Result
V.Conclusion

Finally,followed by the references.

II. LITERATURE SURVEY

P. Divya Vani and K. Raghavendra Rao et al [1]this paper is to developed a system for monitoring the soil moisture content of soil by using IOT, mobile computing technology and cloud computing.M.Usha Rani, S.Kamalesh et al[2]design a wireless sensor network using an arduino with a grove moisture sensor and water flow sensor. It uses a zigbee protocol for the communication among them and the status of the system will be displayed on web portal. The intimation about the water flow will also sent to the user's phone using GSM. Fatihabinti Abdullah et al [3] the analysis of different types of moisture sensor compared to the different types of soil. It includes sensors like commercialized soil moisture sensor, galvanized steel nails and gypsum block and soils taken in experimentation were silt oil, clay soil, sandy soil.
Lee, M., Hwang, J.&Yoe, H.et al [4] developed an IoT based monitoring system for analysing crop environment. Different sensors like temperature, humidity, soil EC and, soil pH sensors are used for crop environment analysis. Based on the analysis the decision support system is developed for agricultural production forecasting. Kodali, R. K.et al [5] has designed weather station based on IoT technology by using Node MCU as a main component and sensors like temperature and humidity, pressure, raindrop and, light dependent resistor. The values of these weather parameters are then uploaded to the cloud, IBM Bluemix. Tai, W. C.et al [6] proposed wireless monitoring and control system for plant growth monitoring of greenhouse. They have used different types of sensors like temperature and humidity sensor, soil water content sensor and, illumination sensor.
Nicholas Dickey, Manish et al [7] the Automated Intelligent Wireless Drip Irrigation System Using Linear Programming provides to be a real time feedback control system which monitors and controls all the activities

of drip irrigation system efficiently as well as it helps us for to do the efficient water management in order to get more profit with less cost.

Ayday and Safak et al [8] presented a moisture distribution map obtained through the integration of a WSN with a GIS (Geographic Information System). The wireless nodes with moisture sensors were located at predetermined locations; geographic coordinates of these points were obtained with GPS and then, all the information was evaluated using the GIS. Vinayak Aappasaheb Pujari et al [9] have proposed the system that uses the solar power panel. This system is used to monitor temperature, wind speed, wind direction, humidity and rain. The sensed data will be sent to GSM module and through gateway to the personal computer. A server is connected to the database.

K.Lakshmisudha, Swathi Hegde et al [10] Proposed a paper which mainly focuses on developing devices and tools to manage, display and alert the users using the advantages of a wireless sensor network system. S. R. Nandurkar, V. R. Thool et al [11] proposes a low cost and efficient wireless sensor network technique to acquire the soil moisture and temperature from various location of farm and as per the need of crop controller to take the decision whether the irrigation is enabled or not.

Prof. C. H. Chavan et al [12] have proposed their system to develop wireless sensor network for an agricultural environment. This system uses the Wireless Sensor Networks which consisted of radio frequency transceiver, sensors, microcontrollers and power sources. Hardware of this system includes 8 bit AVR, ZigBee, Blue tooth module, temperature, humidity, soil moisture sensors, LCD. This system is reliable and efficient for agricultural parameters monitoring.Kadge.et.al [13] proposed Wireless Control System for Agriculture Motor in which he designed a system to control the throughput utilizing the SMS feature of the mobiles. The communication can be through SMS, i.e. the farmer can get message when the motors are ON or when they are OFF.

III. PROPOSED IOT MODEL

i. HARDWARE :

The main hardware of the system consists of Temperature and Humidity sensor(DHT 11), moisture sensor, Node-MCU, Jumper wires.

1. DHT 11 SENSOR :

The sensors used in this work are temperature and humidity sensor-DHT11. The sensorDHT11 is an Analog sensor designed to sense the physical change in heat and moisture when exposed in air with suitable wiring and programming. Its small size, cheap price, low power consumption, quick responses are the characteristics for being one of the best choices for many users. The sensor DHT11 is applicable in HVAC (heating, ventilation and air conditioning), it can be used in testing and inspecting equipment and consumer goods. It is also applicable to use in building a weather station or a humidity regulator. The use of DHT11 sensor has shown its usefulness measuring and controlling temperature and humidity in home appliances, medical and many other sector

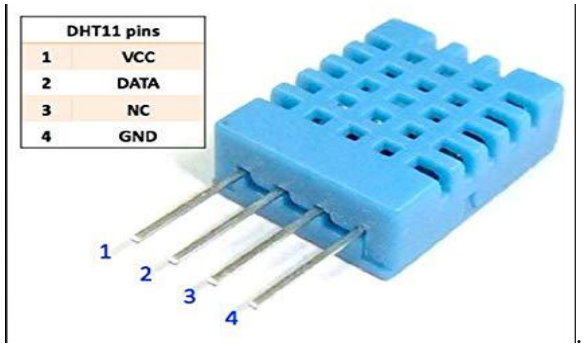

Figure 2 : DHT 11 Sensor

The sensor DHT11 detects moisture in the air by measuring the electrical resistance between electrodes. It is fabricated with a moisture holding substrate. When substrate absorbs moisture, ionization takes place and results in the increase in conductivity between the electrodes. The relative humidity is proportional to the change in resistance between electrodes due to moisture absorbed.

2. MOISTURE SENSOR :

A soil moisture sensor as the name indicates is used to determine the moisture present in the soil. Soil moisture sensor is used for measuring the volumetric water content of the soil and loss of moisture which occurs due to evaporation and plant uptake. For survival of all plants, water is the most important factor. This soil moisture sensor determines the amount of water required for irrigation of plants. This module consists of LM393 comparator with a potentiometer included in it for adjusting the soil wet/dry detection sensitivity according to the requirements of plants.

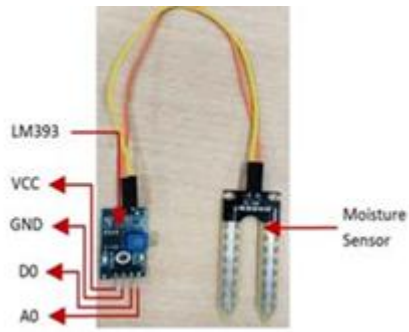

Figure 3 : Moisture Sensor

There are two types of soil moisture sensor: Frequency domain sensor and neutron moisture gauze. Frequency domain sensor has an oscillating circuit which measures the soil water content. The basic principle is that it measures the soils dielectricconstant which determines the velocity of electromagnetic wave through the soil. When the soils water content increases, the dielectric of soil also increases which can be used to estimate how much amount of water the soil holds. Other one is neutron moisture gauze, that works on the moderator properties of water for neutrons. The basic principle is that fast neutrons are emitted from the decaying radioactive source, and when the collision occurs between neutrons and protons, they slow down dramatically. By measuring the density of slowed-down neutrons around the probes of moisture sensor can estimate the volumetric content of water the soil holds.

3.Node-MCU :

Node-MCU is an open source IoT platform with ESP8266-12E chips. It is low-cost, breadboard friendly, integrate a USB to serial chip, and a simple USB to micro USB cable can be used to powered this board. This module aimed for developing ESP8266 based Lua IoT applications and it includes firmware that runs on the ESP8266 wifi SoC from Espressif system. This development board provides access to the GPIO (General purpose Input/Output) subsystem. Based on ESP8266 there are jungle of available modules and every module has certain advantages and disadvantages, depending on the targeted application.

Figure 4 : Node-MCU

NodeMCU is an open source Lua based firmware for the ESP8266 WiFi SOC from Espressif and uses an on-module flash-based SPIFFS file system. NodeMCU is implemented in C and is layered on the Espressif NON-OS SDK. The firmware was initially developed as is a companion project to the popular ESP8266-based NodeMCU development modules, but the project is now community-supported, and the firmware can now be run on any ESP module.

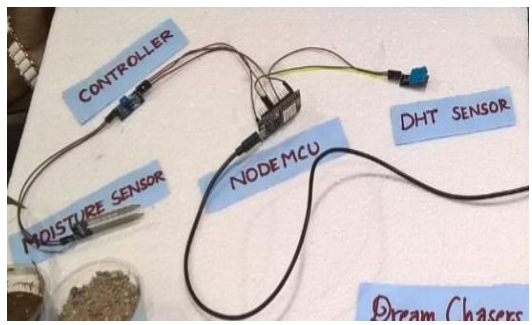

Figure 5 : proposed hardware model

ii. SOFTWARE :

The software we use in Smart Weather and Soil Monitoring is Arduino IDE. The brain part of the building monitoring system, the Arduino IDE (integrated development environment), is a software development environment or software application for Arduino where we can write different kind of computer programs and test. We can write codes in IDE in a language which an Arduino understands, i.e. C, C++. The program (codes) written in IDE, when uploaded into the Arduino microcontroller determines what and how the system works. The Arduino IDE comes with a 'built-in code parser' that studies the validity of the written codes before sending it to the Arduino. The compilation and translation work is done in IDE after checking the validity of codes. After translating the code, the IDE uploads the program to the Arduino microcontroller. IDE software includes the set of different programs that are ready for being tested on the device. The software page where Arduino codes are written has two main functions 'setup ()' function and 'loop ()' functions. The setup part is where the codes should be written so that the program runs and the loop part is where the codes should be written so that the program runs with repetition until the power off or reset button is pushed. It allows users to program and edit Arduino to do anything. Depending upon the feature of different boards, the IDE enables communication with Arduino board through USB. The following figure shows the screen capture of Arduino IDE.

The NodeMCU packages should be installed into Arduino existing library,only then the code written for NodeMCU will be executed.Code written for this model includes two in built libraries in it namely "ESP8266WiFi" and "PubSubClient".The first header file ESP8266WiFi is used to the code that is written to

connect the NodeMCU to the wifi mentioned in the code.The second header file PubSubClient is used to the code that will display the output.
Arduino IDE can also be extended with the use of libraries; the IDE installation includes the installation of number of libraries and an USB driver is installed in the Arduino IDE. For the Smart Weather and Soil Monitoring also include few libraries to be installed. The required libraries are

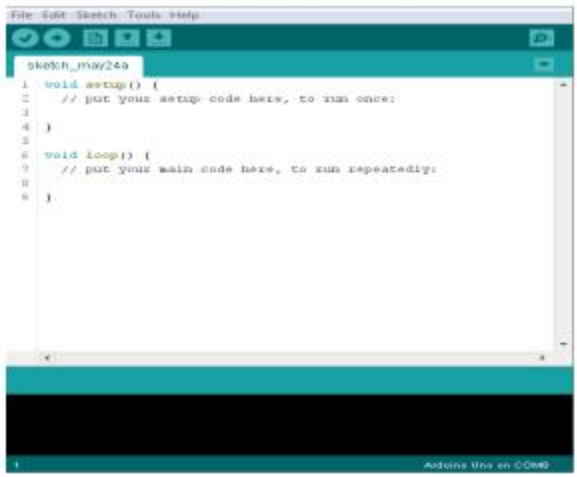

Figure 6 : Arduino IDE

PubSubClient, ArduinoJson, DHT and ESP8266WiFi. These libraries help to get accessed with DHT sensor, soil moisture sensor, NodeMCU and internet.

iii. WEB DESIGN:

Node-RED is an open source.It was created by the IBM Emerging Technology organisation.It is included in IBM's Bluemix IOT starter application package. Node-RED is a programming tool that wires together hardware devices,API and online services.It is a visual tool designed for Internet of Things.Node-RED enables users to stitch together web services and hardware by replacing common low-level coding tasks and this can be done with a visual drag-drop interface.Various components in Node-RED are connected together to create a flow.In this project we used debug node,input node,output node,dashboard nodes and function nodes.
Drag and drop an input and output Node in the flow double click on them and edit API(Application Program Interface) key and token, and with the case of output node and deploy them by clicking on a bug symbol which is at the right side of the page. Connect the both the nodes eith a flow.
Now, drag and drop three function Nodes which is used for three parameters such as temperature, humidity, and soil moisture. Double click on every function separately and edit the name of the nodes as temperature, humidity, and soil moisture respectively. Now connect these three function nodes to the input and output nodes.
Now, we need to visualise these values for that we require dashboards nodes. Dashboards nodes are to be installed separately.
To install a dashboard node follow the below steps mentioned.

1. Go to menu and click on palette.
2. Click on install.

So, Dashboard nodes are installed successfully.

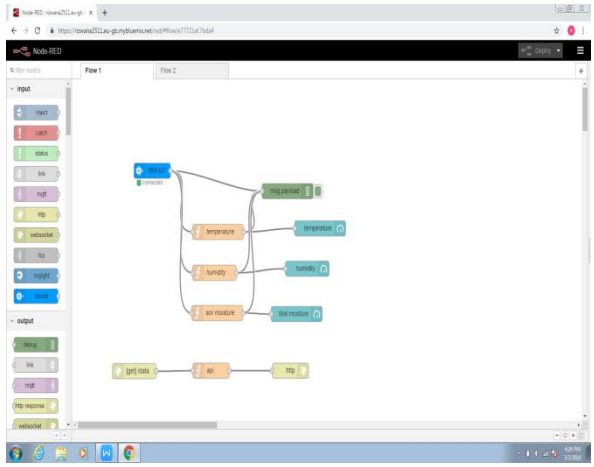

Figure 7 : Node-RED model

- **IBM IoT node** : This is ibmiot node in input nodes.This node can be used with Watson IoT platform to receive events sent from devices,receives commands sent to devices ,or receive status updates concerning devices or applications.It produces an object called msg and sets **msg.payload** to be a String containing the payload of the incoming message.This node is connected to three function nodes,they are temperature,humidity and soil moisture nodes.
- **msg.payload node** : This is a debug node in the output nodes.Displays selected message properties in the debug sidebar tab and optionally the runtime log.By default it displays msg.payload .This node is connected to three function nodes i.e;temperature,humidity and soil moisture nodes.
- **temperature,humidity,soil moisture nodes** : These three are the function nodes in the function nodes.This function nodes run the JavaScript function against the messages received by the nodes.These nodes are connected to IBM IoT node,msg.payload node and three gauge nodes i.e;temperature,humidity and soil moisture nodes.
- **Temperature,humidity,soil moisture nodes** : These are the dashboard nodes.These three are the gauge nodes and they add a gauge type widget to the user interface.This node is connected to three function nodes.They are temperature,humidity and soil moisture nodes.

These nodes are connected together in order to get the output on the web application.

Figure 8 : Node-RED for mobile application

- **[get]/data node** : This is a input node.This node creates an HTTP end-point for creating web services.This node is connected to api function nodes.
- **api** : This is function node in the function nodes.This node runs the JavaScript function block against the messages that are being received by it.This node is connected to [get]/data node and http node.
- **http** : This is a http response node in the output nodes.It sends responses back to requests received from [get]/data node.This node is connected to http node.

These nodes are connected in order to get in result in the mobile application.

iv. MOBILE APPLICATION

The present system developed has a android app, which is named as “smart weather and soil monitoring” .In this app the current values of temperature,humidity and soil moisture are displayed.when the soil moisture is less than 30 then the message will the sent to the device saying “humidity is low,water the plants”.All these are done using MIT App inventor.This is an app inventor for android.

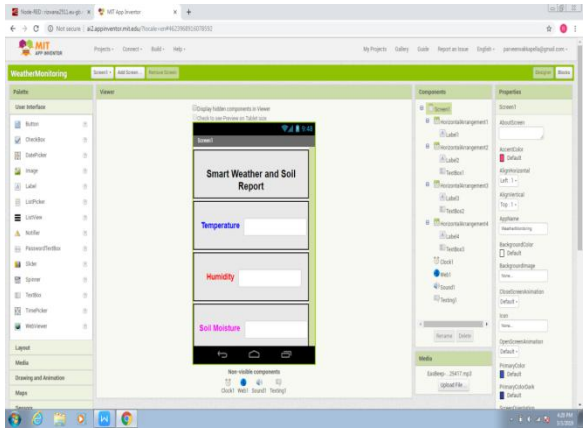

Figure 9 :Designer Model

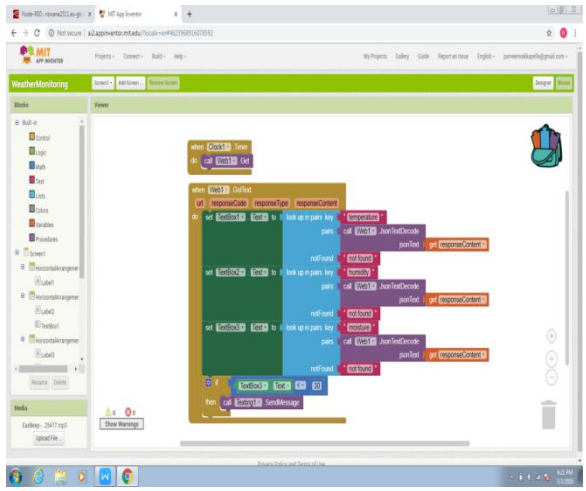

Figure 10 : Block Model

A label displays a piece of text,which is specified through the text property.So,we used labels to write the names i.e;Smart Weather and Soil Report,temperature,humidity,soil moisture names.A box is used to enter some values or display them.Here the values are to be displayed.So,to display the values of temperature,humidity and soil moisture three text boxes are used.All the values to be displayed are present in the web.So,to access the values present in the web firstly we need to connect .It is possible by using a non visible component call web.This web provides functions for http get,post,put and delete requests.We also used a non visible component called clock,it takes the values based on the time specified in its properties.We also used one more non visible component called texting where the message we get is written and also the phone number is also written in its properties.All these comes under designer part.App work only when the block part is clearly written.

In the block part we take the values from web1 and access them in the background using some built in functions and some other functions that are required to get the values.we used a if loop to send a message to user .This message is sent to the specified mobile number having text as “moisture is low,water the plants” when the value of soil moisture is less than 30.

IV. RESULT

The complete hardware and software setup have been done to monitor the soil moisture of the field. We have tested in a small scale by inserting a moisture sensor and visualize the readings. In order to view the results in Arduino platform, a dashboard is created named Node-Red. After detecting the data from different sensor

devices, which are positioned in particular area of interest. The sensed data will be automatically sent to the web server, when a proper connection is recognized with server device. The web server page will allow us to monitor and control the system. By entering IP address of server which is placed for monitoring we will get the equivalent web page. The web page gives the information of the weather, humidity, soil moisture and parameters in that particular region, where the embedded monitoring system is placed. Three gauze blocks for temperature, humidity and soil moisture are being customized to view the moisture level over time.

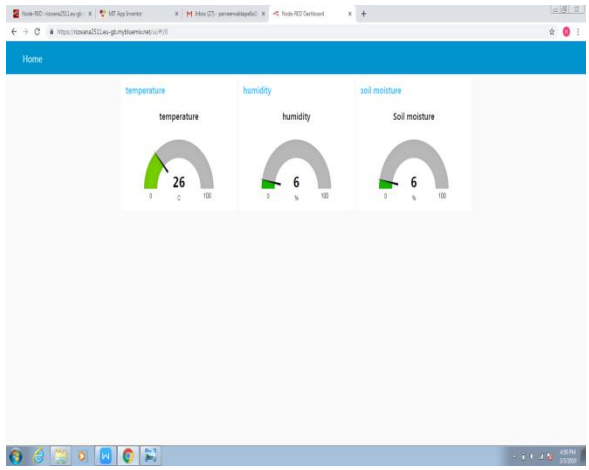

Figure 11 : Web Page Result

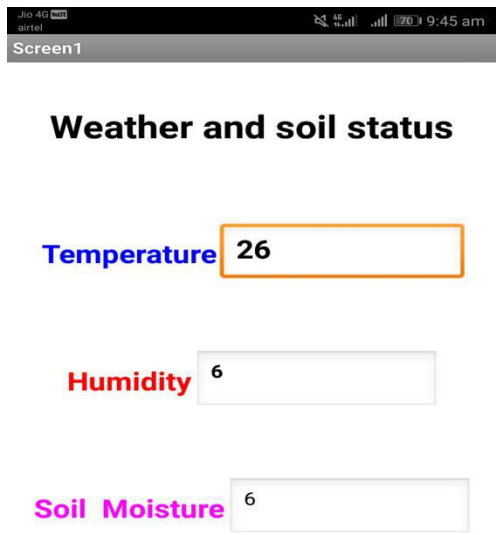

Figure 12 : Mobile Application Result

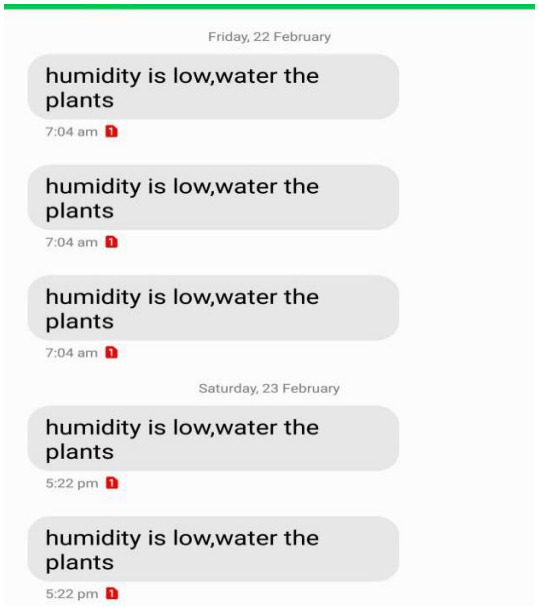

Figure 13 : Message Result

In the android mobile app temperature, humidity and soil moisture values are displayed.This is shown in figure 12.The app has a header as Weather and soil status.At the Temperature label in the text box present next to label temperature value is displayed.At the Humidity label in the text box present next to the label humidity value is displayed.At the Soil Moisture label in the text box present next to the label soil moisture value is displayed.This values will be updated for every one second.The values that are seen here are the same values that are present in web output.An alert message will be sent to the specified mobile number that is given during the design of the app.When the humidity is low i.e;when soil moisture value is less than 30 then message will be sent as "humidity is low,water the plants".In figure 12 the value is 6,at this time a message is being sent to the specified mobile number, it can be seen in figure 13.The code the successfully executed and the result is succesfully obtained.

V. CONCLUSION

The low-cost and reliable weather and soil monitoring system is designed and an android application is developed to view various parameters. The soil moisture response monitoring system designed is very simple to understand and handle. It can be operated by all age-groups of farmers. The moisture is measured up to the root zone of the crop. Thus it can be used to check the moisture value for any crop. Sensor can be placed vertically in the soil to check the depth of irrigated water. IoT-Based temperature and humidity monitoring system provide an efficient and reliable system for monitoring agricultural parameters.

We have import work flow in MIT app inventor platform to setup an alerts via SMS using mobile application.This alerts will be active whenever the moisture level of the plants will be less and we are being notified by SMS.The data getting from the system have numerous applications such as it can be used for soil sampling for soil remote sensing. It can be used for soil and weather data modelling and soilwater balance modelling.Its is will be of a great use to farmers becaues they can record all the values of temperature,humidity and soil moisture in different seasons and compare all the values and come to a conclusion that at whivh season which crop should be grown.so that farmers can increase the production.This system could be improved if parameters like soil pH, soil nutrients, wind speed, wind direction and solar radiation are added to it.

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