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IoT Enabled Smart Farming and Irrigation System

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***Abstract*—IOT plays a major role in agricultural field. This paper is mainly applied to agricultural field. Smart irrigation and farming can help farmers to grow healthy plants. The existing system only checks the soil water stress and automates the process of watering. The paper is about IOT based smart farming and irrigation system. The ultimate agenda of this paper is to automate the process of watering to plants. This work helps us to know the values of various parameters such as humidity, moisture and temperature of plants and water them accordingly. The system consists of three sensors which sense the values of humidity, moisture and temperature of plants. If any of the values decreases the motor automatically turns on the water for plants. This is done using Arduino board, voltage regulator and relay which controls the motor. WIFI module is used to inform the user about the exact field condition. The various sensors send the values to the Arduino board which has been coded with if else conditions will further pass the commands to the relay which turns on or off the motor according to the conditions given. If the sensor values are decreased, it turns on the motor else it turns off the motor. The ultimate significance of this paper is that most of the manual work is reduced and watering process is automated with the help of devices as a result of which healthy plants can be grown. Water and electricity usage are saved by this paper. Even elderly people can easily do farming. The paper has been used to grow a tomato plant and it was successfully grown by automatic process. This methodology with the use of IOT technology had made us achieve a healthy farming. Increase in agriculture also helps us to increase the economical state of the country.**

***Index Terms*—Android, Sensors, Relay, LCD, Voltage regulator.**

1 INTRODUCTION

The paper is all about IOT based smart farming and irrigation system. This paper plays a major role in agricultural field. Farmers are most benefited by this paper. This can bring a change in economic state of the country like India which depends on agriculture. The paper consists of various components such as different sensors, Arduino board, power supply, LCD, relay and a motor. The main objective is to automate the process of watering to the plants. The various parameters of soil and plant are sensed by using different sensors. In this paper, temperature, humidity and moisture sensors are used to sense the values. When there is an increase in any of this sensor values relay will make the motor on which automates the process of watering. The conditions are given in the Arduino board when to switch on or off the motor.

This reduces the manual work. Farmers need not strain themselves in maintaining and preventing the plants. This saves both electricity and water. Farmers sometimes forget to switch off the motor which leads to wastage of water and also electricity. These disadvantages can be easily solved with the help of this paper. This paper does not always need a person to monitor the plants. The paper uses IOT technology, and it monitors each and every parameter of plants and it accordingly waters the plant. Even an elderly person can do farming with the help of this paper. This is seen to be an effective method for farming. This helps farmers to grow healthy plants. This kind of paper is especially needed in country like India where agriculture plays a vital role in economic condition of the country.

I. RELATED WORKS

S.K. Luthra [1] design and developed an automated irrigation system that continuously observes water stress in the soil and helps to control irrigation as per the scheduled values of soil water tension. Soil water tension is sensed tensiometer. The tensiometer produce a proportional electrical signal for various soil water tension values. The signal reaches the dc motor. The dc motor open or closes the valve according to the respective signals. The low-cost auto irrigation system helps Indian farmers by reducing manual work. The controlled scheduling of tensiometer is specifically applicable for localized irrigation setup and it only includes one parameter. Hence, these are the disadvantages of this system.

Suhinthan Maheswararajah [2] stated the Orphaned-Nodes management for Smart Irrigation Systems in Wireless Sensor Networks. It analyzed the problem in agricultural farm where the orphaned node management in a wireless sensor network is deployed for automated irrigation. Each sensor node has a measurement which includes temperature and soil moisture level in that area with white Gaussian noise. Restoring the orphaned nodes in the network is possible as it can still receive and communicate the messages, which does not take place in exhausted or dead nodes. Thus, it reduces the irrigation cost by improving the estimation of field parameters. It is possible that the noises considered in the models may not be Gaussian in some cases. To handle nonlinear non-Gaussian models, it is necessary that the upcoming research will focus on developing and modifying the algorithms.

Joaquín Gutiérrez [3] proposed a smart phone sensor which is a watering sensor used to capture the images of the soil adjacent to the crops root zone. An Android App was developed in the Smart phone. The mobile App wakes-up the smart phone, activating the device. The ratio between wet and dry land is calculated by taking the picture of the soil through an antireflection glass window in the camera. Once the Wi-Fi connection is enabled, the water pump is controlled by transmitting the ratio to a gateway via a router node. To preserve its energy, the app sets the phone in a sleep mode at the end. When it was tested in a pumpkin crop, its results shows that the use of Smartphone sensor is become a practical tool for farming. This is a costly process.

Chetan Dwarkani M [4] proposed a Smart Farming System Using Sensors for Automation Task in agriculture. The sensor in the Smart phone provides accurate results and based on the crop needs the nutrients is sprayed by Smart watering system. It is mostly depending on moisture content in the soil. This paper will increase the agricultural productive force because of its smart irrigation system. It will also change the production methods and produce quality products. This paper is not applicable for larger fields.

G.Shruthi [5] proposed a controlling system for irrigation which is real time smart sprinkler. This paper plays vital role in domestic agricultural field. This system helps in supplying the necessary water whenever the plant requires. Developing Arduino ATMega238, which is a Microcontroller form of smart Sprinkler that improves the embedded technology in the field sector. Thus, it increases the irrigation process to an extent. This Smart sprinkler system helps the farmers to reduce their works, saves the time in the agriculture and getting more crop yield. It will be helpful to strengthen their economic value. The Smart sprinkler system has an automatic processing ability that will optimize the water quantity in the agriculture, thus it helps in water conservation.

Dr. J. JegatheshAmalraj [10] conducted a comparative study in their research work with various existing technologies that have been prevailing. They also stated that drip irrigation is the most valuable source of irrigation for farming. This is because water can be saved in large volume in drip irrigation than traditional farming. Laura García [11] in their review paper validated all possible irrigation methods suggested with IoT devices. They came to a conclusion from their research work that wifi is the promising communication technology that can be used for transferring the data from the device to the users. This accounts for our proposed model. Henceforth the Wi-Fi signal we process reaches the users at a faster speed because of its bandwidth. I.D. Ighodaro [12] discussed that soil practices with the help of machine learning technology. They used techniques for climate smart agriculture process. J.Arumai Ruban [14] et al, mentioned different kind of approaches for smart irrigation system and said that sensors are used to determine temperature, rain fall, leaf wetness, humidity and Ph values of soil. Thus, the sensor will transfer he information from the soil to the Arduino UNO. Velmurugan [15] et al, provided us a algorithm implied to the system which helps in transferring the data from the soil to the board. Akey Sungheetha[13] et al proposed a sensor based system for fire detection using IoT platforms.

II. PROPOSED DESIGN

In the proposed system, the watering process is automated which reduces manual work. Various parameters of the plants and soil such as temperature, moisture and humidity are sensed with the help of different sensors. When there is a decrease in any of the sensed values, it sends a signal to relay which in turn switch on the motor to water the plants automatically. Farmers can also view the exact field condition with the help of their smart phones through an app. Figure1show the architecture diagram

A. System Model

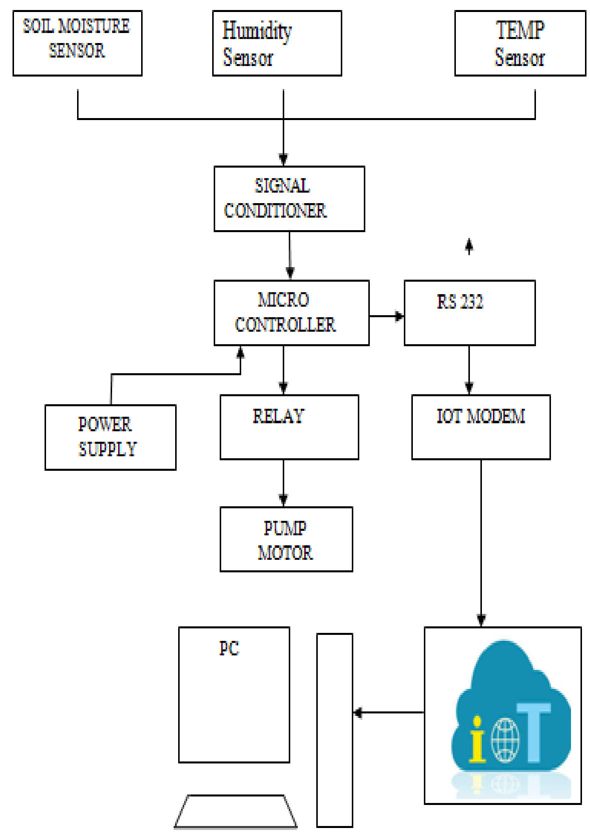

Fig 1 Architecture diagram

B. System Overview

The Arduino UNO contains Micro Controller and signal conditioner within it. The Ardunio UNO can withstand only maximum of 12volts electric supply. The 12 volts power supply is produced into voltage converter, where the 12 volts regulated to 5 volts. The 5 volts power supply is now produced into the Arduino UNO.

The moisture sensor senses the water content of the soil. The Humidity sensor senses the moisture content in atmosphere. The Temperature sensor senses the atmospheric temperature. These three sensors are connected to the arduino

UNO board. The signals obtained from these sensors are sent to the arduino UNO. Then it sends the value to the LCD.

The relay is directly connected to the power supply to run the motor of 12 volt power supply is which is given to run the motor

If the moisture content in the soil reduces to 1000, the relay switches on the pump motor. The temperature in the atmosphere is calculated using the derivation. It converts the temperature value from 10 bit analog value to Celsius value. This Celsius value is converted to the Fahrenheit value using the derivation. The need for water supply is found out using the temperature value. If the temperatures inflate about 40° Celsius the relay switch on the pump motor and vice versa.

The value obtained from arduino UNO is sent to the WIFI modem. WIFI modem is used to monitor the plant from wherever you want. The ESP8266 WIFI modem is connected to the user's mobile using the app in MQTT dashboard. A server called IOT.eclipse.org help to connect the MQTT app.

The login in and password to login to the app is created using coding. Now the MQTT server and ESP8266 WIFI modem is connected. The needed entity in the app is created by using irr/moisture, temp, and humidity, motor. The required value can be obtained.

C. *System Implementation*

This paper deals with the automatic maintenance of agricultural fields with proper irrigation. The system consists of water level indicator, sensors, relays, signal conditioner, micro controller, IOT modem and a pump motor. The controller receives the signal from the sensors and controls the irrigation accordingly. Through the relay, the pump motor is ON and OFF. A touch sensor continuously monitors the fields so as to alert the farmer of any animals that might enter the fields knowingly or unknowingly. The status of the land is intimated to the server through IOT.

The Algorithm for Liquid Crystal Display code is implemented as follows,

Step 1: Declare variables for various sensors such as humidity, moisture and temperature and also for LCD pins

Step 2: By using set up( ) function set cursor at specific row and column for displaying various words.

Step 3: Set both input and output pins in pin mode.

Step 4: Use void loop ( ) function to repeat the process.

Step 5: The output values of moisture, temperature and humidity are displayed in analog, degree Celsius and percentage respectively.

Step 6: Map ( ) function is used to convert the analog values in to degree celcius and percentage.

Step 7: Serial.print is used to print the output on the screen and lcd.print is used to print it on the lcd.

Step 8: If moisture is greater than 1000 or if temperature is greater than 40 degreecelcius the motor switches on.

Step 9: Else the motor automatically switches off the flow of water.

Step 10: Void Serial_ send( ) is used to send the output to the WIFI modem. The flow diagram of liquid crystal display is shown the Fig 2.

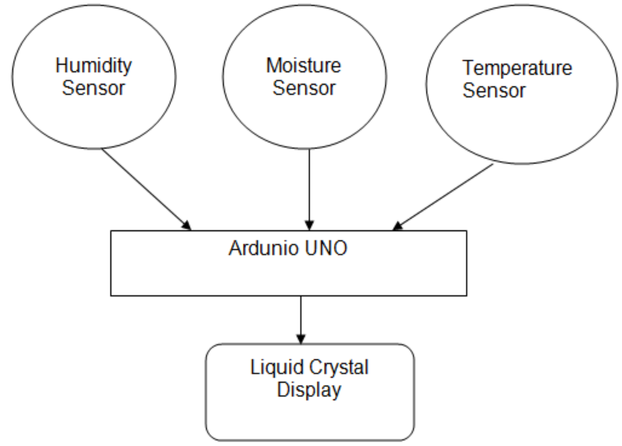

Fig 2 Flow Diagram of Liquid Crystal Display

The Algorithm for WIFI modem code is implemented as follows,

Step 1: Declare variables for id, password and mqtt _server and position.

Step 2: void setup() is used to set wifi and mqtt server.

Step 3: Serial.println is used to keep track of what is loaded.

Step 4: We start by connecting to a WiFi network using void setup_wifi().

Step 5: while condition is used to check whether the wifi is connected or not.

Step 6: Serial.print is used to print the output on the screen and lcd.print is used to print it on the lcd.

Step 7: Serial.read() gets one byte from serial buffer.

Step 8: client.publish () is used to getb the output on the mobile app. The flow diagram of WIFI modem is shown the Fig 3.

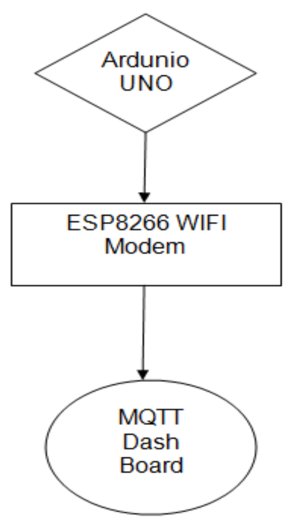

Fig 3 Flow Diagram of WIFI modem

The Algorithm for moisture sensor code is implemented as follows,

Step 1: Declare variable for moisture sensor.

Step 2: Void setup ( ) function is used to set pins in pin mode.

Step 3: Serial. begin is used to start the serial communication at 9600 bits per second.

Step 4: The loop routine continues to run forever with the use of void loop( ).

Step 5: Analog Read ( ) reads the input on analog pin.

Step 6: Serial. Print prints out the value you read.

Step 7: If value is greater than 1000, the motor switches on

Step 8: Else the motor automatically switches off the flow of water. The flow diagram of moisture sensor is shown the Fig 4.

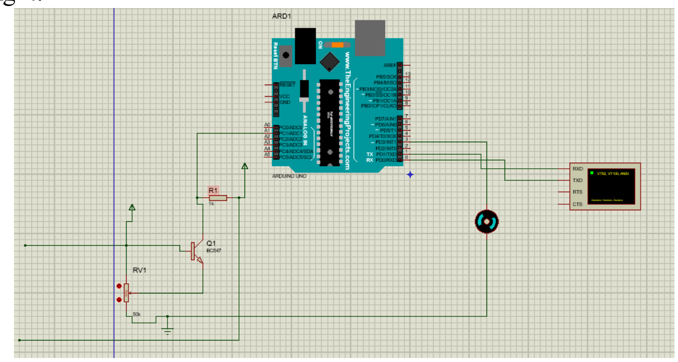

Fig 4 Flow Diagram of moisture sensor

The Algorithm for temperature sensor code is implemented as follows,

Step 1: Declare variable for temperature sensor.

Step 2: Void setup ( ) function is used to set pins in pin mode.

Step 3: Serial. Begin is used to start the serial communication at 9600 bits per second.

Step 4: The loop routine runs over and over again forever with the use of void loop( ).

Step 5: Analog Read ( ) reads the input on analog pin.

Step 6: The analog value has to be converted in to degree Celsius by using certain formula.

Step 7: Serial. Print displays the temperature in Celsius. The flow diagram of Temperature sensor is shown the Fig 5.

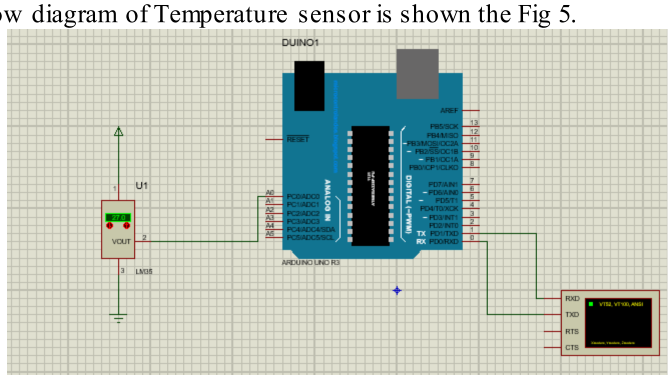

Fig 5 Flow Diagram of Temperature sensors

1 POWER SUPPLY

The microcontroller works only with DC power source. As it doesn’t work with the domestic AC power source (230v), SMPS is used for converting AC power supply to DC power supply. The microcontroller is connected to the SMPS for power supply. The SMPS provides +5v DC to turn on the micro controller. The other circuits are also dependant on SMPS for power supply.

2 MICRO CONTROLLER

PIC 16F877 micro controller has been used in this paper. This device comes with 5 ports and 40 pins. The input and output taken and given respectively from the micro controller is always digital.

3 RELAY

Relay needs 12v power supply for functioning, so it is linked directly with the power source. Relay is nothing but a control device which acts a switch. It is used to turn the motor on and off automatically.

4 DC MOTOR

If the temperature exceeds 40ºc, the relay will switch on the DC motor which will pump water to plants. And when the temperature becomes less than 40ºc, the relay will switch off the DC motor. If the moisture exceeds 1000, the relay will switch on the DC motor which will pump water to plants. And when the moisture becomes less than 1000, the relay will switch off the DC motor.

Various Modules of the application are as follows:

The IOT based smart farming and irrigation system consist of three phases namely the following,

- Sensing the outer environmental temperature

In this Thermistor 103 is also a one of the part of temperature sensor. This can sense room temperature and atmosphere temperature. This helps us to identify the temperature of the particular area where plant can grow.

- Sensing the water content of the soil

In order to get an accurate measurement, a moisture sensor is also needed for calibration. The moisture sensor senses the water content of the soil. If the moisture content in the soil reduces to 1000, the relay switches on the pump motor.

- Sensing the Outer Environmental Humidity

When the moisture content in the atmosphere is low, then relay switches on the pump motor.

III. COMPARISON

This hardware is tested for a different soil in our institution. The moisture, humidity and temperature content of the soil were checked periodically with the help of the app and the growth of the tomato plant is monitored. At the end, the plant bore a fruit.

TABLE I

Time	Temperature	Moisture	humidity	Motor status
1	28	700	35	Off
1.10	30	1000	37	On
1.15	35	900	39	Off
1.20	40	1010	45	On
1.25	43	1050	47	On
1.30	45	1100	51	On

Reading of various sensors at different time

This shows the status of the motor based on the values of the three sensors.

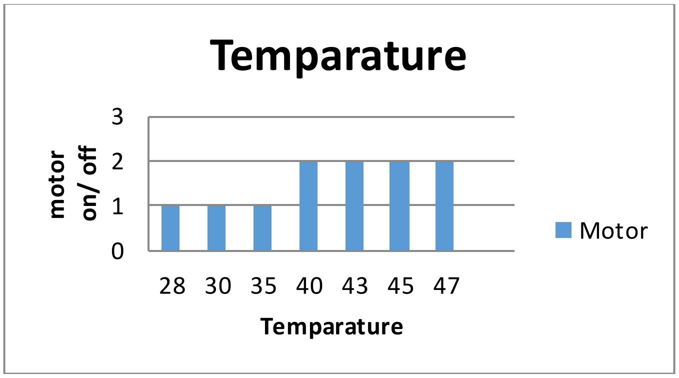

Fig 6 this graph shows the comparison between motor status and the Temperatures sensors

When the temperature is between 28-35 the motor is in off state 1 whereas when the temperature is between 40-46 the motor is in on state 2 as shown in the Fig 6.

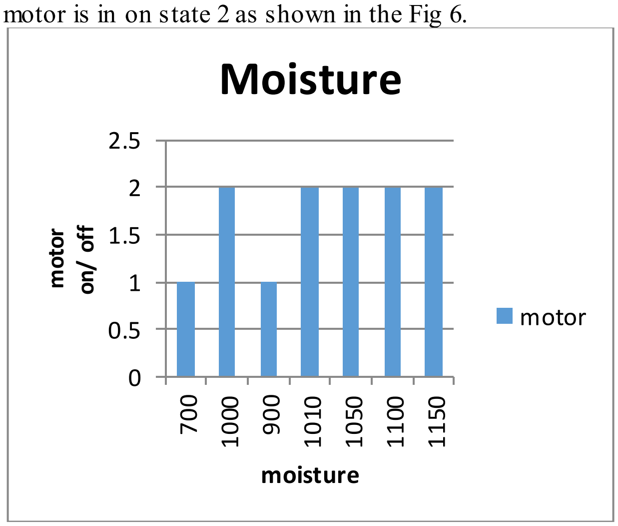

Fig 7 this graph shows the comparison between motor status and the moisture sensors.
When the moisture is less than 1000, the motor will be in off state 1. Whereas when the moisture is greater than 1000, the motor will be in on state 2 as shown in Fig 7.

IV. PERFORMANCE ANALYSIS

In this system the Arduino is connected with the WIFI modem as shown in the Fig 8. Circuit connection between the Arduino and WIFI modem is made using wires. The farmers can keep track of the temperature, moisture, humidity and motor using MQTT Dashboard application which is available for both android and IOS. This app is connected to the IOT modem in the system using personal area network (PAN) by applying required network configuration.

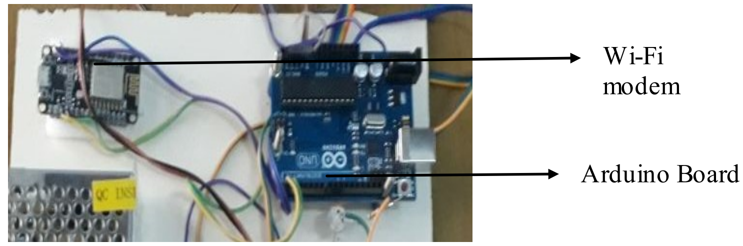

Fig 8 Connections between Arduino and the WIFI Module

In this system, the arduino is connected with the DC motor by using the wire as shown in the Fig 9. Circuit connection between the arduino and DC motor is made using wires. Relay will turn on and off the DC motor according to conditions given.

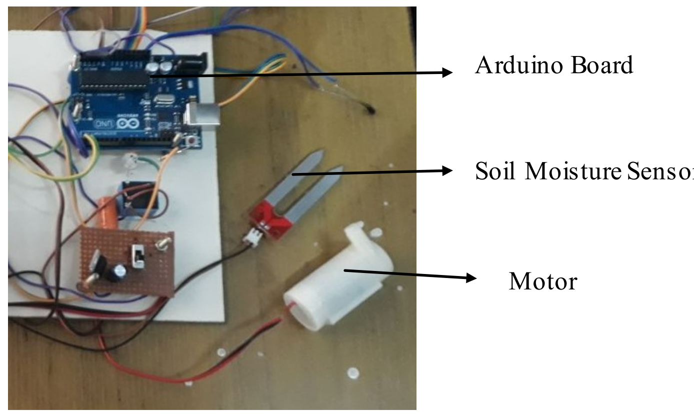

Fig 9 Connections between Arduino and Dc Motor

In this circuit diagram, the overall connections made in paper using the arduino, WIFI modem, relay, voltage regulator, SMSP is shown in the Fig10

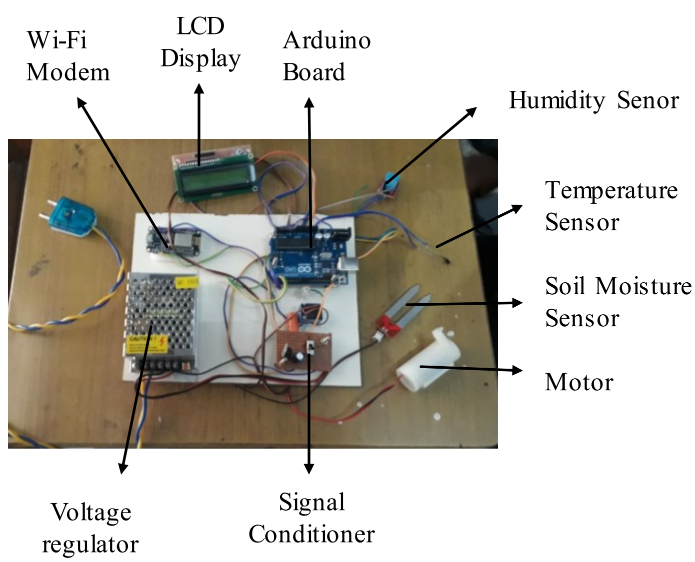

Fig 10 Iot Based Smart Farming & Irrigation System

The MQTT dashboard is an application which is available in both versions of android and IOS. The MQTT dashboard is connected to the system via IOT modem by doing several configurations. The Fig 11 shows output of MQTT Dashboard

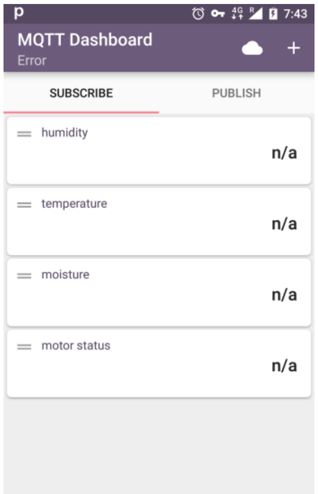

Fig 11 MQTT Dashboard

V. DISADVANTAGES AND SETBACKS

Some of the major disadvantages are discussed below:

- Failure of one component results in malfunction of the system.
- When there is no power supply, the system cannot send signals and process the irrigation system.
- Maintenance of the system is a tedious process
- Repeated monitoring is required.

VI. CONCLUSION

The significance of this paper is that manual work is reduced, and watering is automated. Healthy plants can be grown with limited use of water and electricity. Even elderly people can easily do farming. IOT plays a major role in agricultural field. This paper is mainly applied to agricultural field. The paper has been used to grow a tomato plant and it was successfully grown by automatic process. It helps us to achieve a healthy farming. Increase in agriculture also helps us to increase the economical state of the country.

VII. FUTURE WORK

In future, the system can be extended to a level where different plants get water according to their type, area where the plants are grown. It can also be extended to larger fields and lands. It can even be automated by operating the motor through mobiles. Different types of watering such as drip irrigation etc. can be done according to the plants type.

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