SMART AGRICULTURE TECHNOLOGY
(SAT)

A Project Report

under the guidance of

DR. KUMARAVELU R.

submitted by

17BCE2002 ANUJ
17BCE2006 ANURAJ SRIVASTAVA

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

APRIL 2019

DECLARATION BY THE CANDIDATE

We hereby declare that the project report entitled "**SMART AGRICULTURE TECHNOLOGY"** submitted by us to Vellore Institute of Technology, Vellore in partial fulfillment of the requirement for the award of the degree of **B.Tech.** in **Computer Science and Engineering** is a record of J component of project work undertaken by us under the supervision of **Dr. Kumaravelu R.** We further declare that the work reported in this report has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

Place: Vellore Institute of Technology, Vellore
Date: 09th April 2019

Signature of the faculty

Signature of the candidate(s)

Smart Agriculture Technology (SAT)

Anuj[1], *Anuraj Srivastava*[2]

[1] *2nd Year, B.Tech., Computer Science and Engineering, Vellore Institute of Technology, Vellore, Tamil Nadu*
[2] *2nd Year, B.Tech., Computer Science and Engineering, Vellore Institute of Technology, Vellore, Tamil Nadu*

2. OBJECTIVE

- ✓ Usage of micro-processors, help alleviate food shortages by enabling more intensive use of farm land that results in higher outputs.
- ✓ Microprocessors also help livestock farming or ranching be more productive in the use of water, energy, food and other resources and even help track the location of livestock.
- ✓ More applications based on interfacing microprocessor technologies have become feasible because the cost and size of sensor devices continues to decrease and their sophistication for measuring conditions keeps increasing.
- ✓ Result in more effective energy use for pumps, boosters, lighting and other purposes. Thus, also help water use be more productive based on the type of soil and other conditions.
- ✓ Data analytics software can provide actionable information by combining information on current weather, the slope of the land, type of soil and exposure to sunshine with data captured by sensors measuring moisture, heat, chemicals and other conditions.

3. ABSTRACT

Scarcity of irrigation water in critical time and over watering of the farms due to lack of knowledge is one of the problems which is affecting the yield of the crops. In our project we will use the Internet of Things concept which will alert the farmers, about how much water is needed and how much fertilizers they should use at various critical stages so that it can increase the yield. Decision making algorithm has also been proposed as per the attribute requirements like humidity in soil, various chemical composition like P, Ca, NH_4 *and other organic compounds etc., water, temperature. Micro-processor concepts are fused with the agriculture industry so that yield and quality of crop can be improved and thus scarcity of food will decrease which will lead to decrease in world hunger and a drastic improvement in the quality and the organic nature of the food that we consume. This would also lead to a better society where the farmers are in parallel with the other classes present in the society.*

4. INTRODUCTION

In crop farming, data analytics software can provide actionable information by combining information on current weather, the slope of the land, type of soil and exposure to sunshine with data captured by sensors measuring moisture, heat, chemicals and other conditions. Each sensor can monitor a specific condition or set of conditions. Water, fertilizer and pesticides can be applied in more precise quantities and locations and with better timing which will increase yields.

Water and energy are the most important inputs for agriculture and their costs can make or break an agricultural business. Agriculture is very energy intensive. It can result in more effective energy use for pumps, boosters, lighting and other purposes. Thus, can also help water use be more productive based on the type of soil and other conditions. In California, agriculture consumes about 40% of the freshwater available with a large amount of water being wasted by leaky irrigation systems, inefficient field application methods and the planting of water intensive crops in the wrong growing location.

The micro-processing technologies can make water use smarter for agriculture in irrigation efficiency and lower costs by monitoring and changing water volume, location timing and duration of flow based on data analytics. A network can remotely determine the status and working condition of equipment (open or closed, on or off, full or empty, etc.). The information can be actionable so a gate can be opened or closed or an irrigation pump turned on or off remotely to adjust the flow of water or to save energy or to take advantage of time-of-use energy pricing. Pumps, gates and other equipment can be monitored for vibration and other indications that maintenance or replacement is needed. Along with the irrigation aspect we can also increase the harvest of the crops by monitoring the pH level, temperature and hygroscope etc., with interfacing different sensors with the microcontroller.

At present, there is emerging global water crisis where managing scarcity of water has become a tedious job and there are conflicts between users of water. This is an era where human use and pollution of water resource have crossed the levels which lead to limit food production and low down the ecosystem. The crop water stress index called as CWSI existed around 30 years ago. This crop water stress index was then integrated using measurements of infrared canopy temperatures, ambient air temperatures, and atmospheric vapor pressure values to determine when to irrigate using drip irrigation. The management of these farms which are in greenhouses will require a data acquisition to be located in each greenhouse and the control room where a control unit is located. These are separated from the production area.

At present, the data is transferred using wired communication called field bus. This data is transferred between greenhouses and control room. Different communication technology has been developed for communication between network and its element. ZigBee, WI-FI, Bluetooth, RF are communication technology used in sensor network. RF is preferred over other technology due to low cost and less power consumption.

Web based intelligent irrigation system is solution for this problem. It is automated and micro controlled based can be control from remote location. It takes decision on sensor value of agriculture farm. Wireless sensor Network is back bone of whole system. Sensor node, master node, Base station and server are elements of WSN application. The proposed architecture strives to overcome the mentioned problem and increase the harvest of the crops.

5. LITERATURE SURVEY

Fan TongKe [1] proposed the smart agriculture based on cloud computing. The author presented the architecture for the smart agriculture based upon the concept of the IoT and cloud computing. Agriculture information cloud was combined with Internet of Things to achieve the dynamic distribution of resources and balance of the load.

Ji-Chun Zhao et al. [2] studied the applications of IoT in agriculture. The authors proposed a monitoring system based on internet and wireless sensor networks. An information management system was designed to provide the data for research in agriculture. The authors developed software for monitoring of the fields like data acquisition about the fields, data processing models, and system configuration module. The developed application provides accurate control for the monitoring of the green house.

Agrawal and Lal Das [3] discussed the possible future applications and challenges faced by the IoT technology. They presented some key challenges in IoT applications such as: standards, privacy, security, authentication and identification, trust and ownership, integration, coordination, and regulation. They stated that the use of RFID (Radio Frequency Identification), Wireless Sensor Network (WSN) and mobile communication technologies would reduce the gap between theoretical and practical implementations of IoT applications.

Chen and Jin [4] proposed the ‘Digital Agriculture’ based upon IoT. The working of the digital agriculture is divided into two steps: in the first phase, the information about the temperature, the wind, the soil contents, etc. is collected by different sensors. In the second phase, ZigBee transfers information. The agricultural products have labeled with EPC code. The EPC code reader reads the code of the products.

Li, Li et al. [5] discussed the application of smart and Wi-Fi based Wireless Sensor Network in IoT. The authors discussed the applications of IoT-based upon Wi-Fi, WSN and smart grid. Smart grid provides the intelligent data collection application, improving reliability of data collection and providing accurate information. IoT provides the intelligent environment monitoring application; water data and air data collected through sensors and sent to server for further processing. They proposed the concept of the precision agriculture. The authors stated that new WSN technology is better as compared to ZigBee.

Hussain et al. [6] proposed the application of Internet of Things (IoT) technology in animal stock chain management. By using the RFID technology, anyone can be tracked or monitored. They discussed some operational principle of IoT. RFID technology is used for the unique identification of objects; each object in the RFID is labeled with EPC code. The authors proposed the use of this technology for maintaining all records for livestock management.

Kosmatos et al. [7] proposed the architecture based on the RFID and smart objects. RFID objects will perform the primitive functionality in the proposed architecture while the smart objects will perform the complex functionality. The architecture was proposed based on the integration of RFID and smart objects. RFID tags have widely used for the identification of objects. So, the RFID is used in the proposed architecture for tracking of the objects. The authors used service-oriented architecture and semantic model-driven approach in the proposed architecture.

Carvin et al. [8] proposed the ubiquitous cognitive management system based on IoT and ubiquitous computing. They presented the problems as well solutions of problems. The basic idea was to use ambient intelligence provided by smart objects to serve the human, improving communication by context information.

Prasad et al. [9] proposed an expert system for the diagnosis of pests, diseases, and disorders in mango. The system had developed in ESTA (Expert System Shell for Text Animation). In the proposed system, the first step is the knowledge acquisition; the second step is the diagnosis of disease based on the input. They briefly described the type of mango diseases and recommendations for the disease control on the basis by visual symptoms.

Sarma et al. [10] proposed an expert system for diagnosis of disease in rice plant in India. The purpose of the expert system is to assist farmers in solving the problems. The first step is the development of the knowledge base in the form of condition rules. The proposed system is easy to use and will be useful to those people who are unable to get the assistance of some agriculture expert.

6. EXISTING AND PROPOSED SYSTEM

Existing Model Loophole:

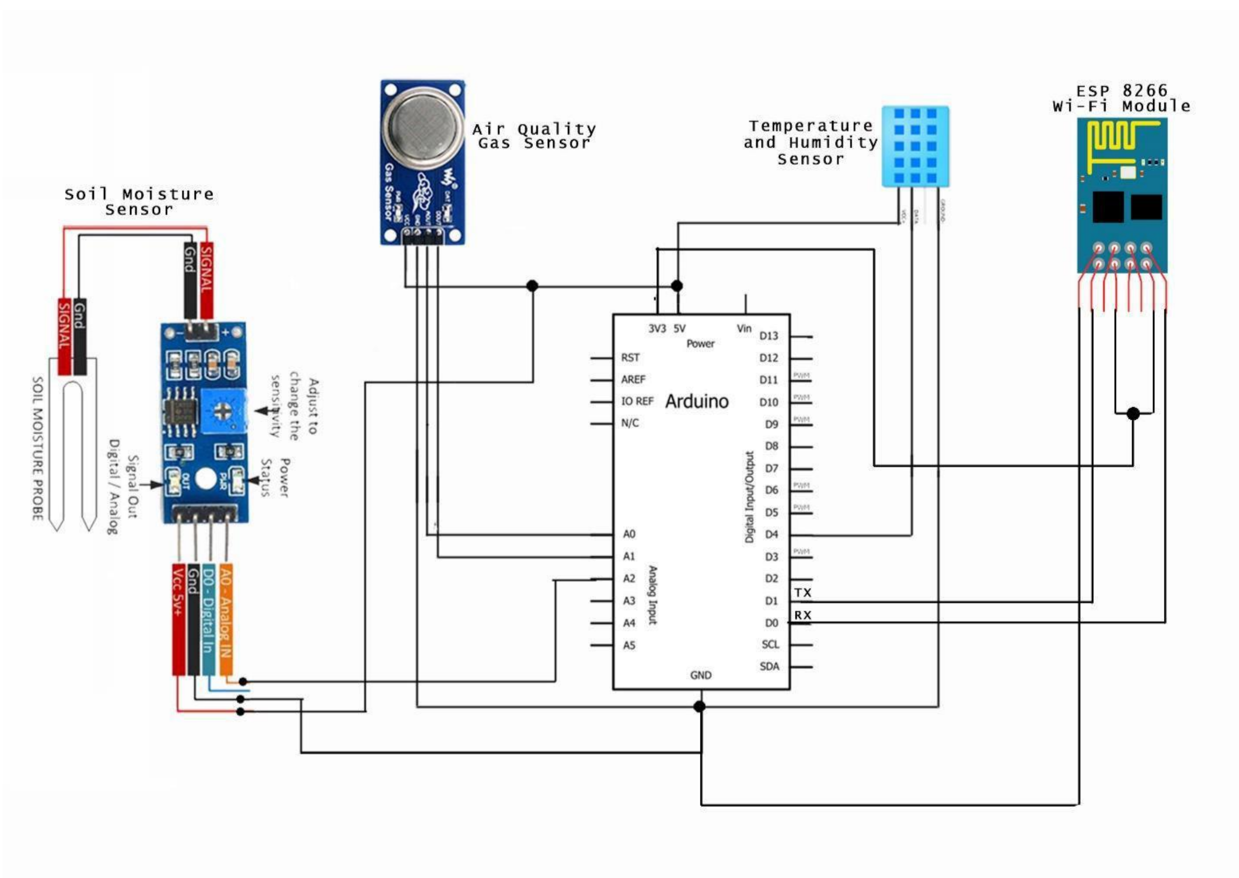
- Different thresholds that is to be compared with the calculated data is mostly incorrect.
- If there is any requirement that should be supplied to the harvesting crop, then the alert system will give the signal to the farmer accordingly otherwise no alert message is send. But not so in existing system. People manually compare and thus results in time lag.
- Data is not collected at regular interval of time, thus delaying the mechanism.

Proposed Model –

In this architecture different sensors like moisture sensor, temperature sensor, humidity sensor and pH sensors are connected with Arduino board which send the data reading after sensing to the Arduino board. Arduino board send those data to the server. At server side the analysis is done of the data received. This data is compared with the different threshold. If there is any requirement that should be supplied to the harvesting crop, then the alert system will give the signal to the farmer accordingly otherwise no alert message is send. The data is collected for the regular time interval of time, the data is pre-processed and mined at the server side. From the mined data some decision rules are created which will help the farmers to improve the quality and yield of the crops.

Our Model is designed to sense physical properties like temperature, humidity, air quality value, gas value (for CO_2 and NH_3) along with Soil moisture using various sensor mentioned in the list above. The respective values are visible in the SERIAL MONITOR of ARDUINO IDE

7. <u>SYSTEM DESIGN ARCHITECTURE</u>



The components that we used for the project –

1. Arduino Uno Board
2. Air Quality Gas Sensor (MQ-135)
3. Soil Moisture Sensor
4. Temperature and Humidity Sensor (DHT11)
5. Bread Board
6. Wires and other basic Components

8. ALGORITHM

1. Soil Moisture giving random false values when in air.
2. ESP Wi-Fi Module was to be connected to 3.3V and not to 5V which resulted in overheating and malfunctioning.
3. Debugging the code for errors which were solved by including various libraries for various sensors and ESP Module.
4. Normal syntax errors.
5. Difficulties in lining the cloud to the Arduino.
6. Wires must not be damaged while usage.
7. Arduino board's 0^{th} and 1^{st} pins are RX and TX resp. but sometimes Arduino malfunctions when pin 0 is connected which was solved by reading solutions on various forums and assigning TX and RX pins at 2^{nd} and 3^{rd} pins of the board.
8. Sometimes ESP operates at 115200 baud rate and hence no output was seen in Serial Monitor and hence its baud rate was changed to 9600 so as to get output.
9. As the circuit is an ensemble of various discrete components, we didn't have any circuit to start with but designed it ourselves understanding connections for each sensor and ESP module and its diagram is also designed manually specifically for our project.

9. SOURCE CODE

System Implementation:

```
#include <SoftwareSerial.h>
SoftwareSerial espSerial =  SoftwareSerial(2,3);
// arduino RX pin=0  arduino TX pin=1

#include <DHT11.h>
int pin=4; // digital pin number 4
DHT11 dht11(pin);

#define airquality_sensor_pin 0
#define gas_sensor_pin 1
#define VAL_PROBE 2
// Analog pin 3
String apiKey = "T51ZQUEPKAU1FCFR";
 // replace with your channel's thingspeak WRITE API
key String ssid="123";
// Wifi network SSID
String password ="12345678"; // Wifi network password

boolean DEBUG=true;

//================ // showResponce || //================

void showResponse(int waitTime)
 {
   long t=millis();
char c;
while (t+waitTime>millis())
{if (espSerial.available())
{c=espSerial.read();
if (DEBUG)
Serial.print(c);
  }
    }
            }

boolean thingSpeakWrite(float value1, float value2, int value3, int value4, int
value5) { String cmd = "AT+CIPSTART=\"TCP\",\""; // TCP connection
cmd += "api.thingspeak.com";
cmd += "\",80";
  espSerial.println(cmd);
if (DEBUG)
Serial.println(cmd);
if(espSerial.find("Error"))
```

```
{
if (DEBUG)
Serial.println("AT+CIPSTART error");
return false;   }
String getStr = "GET /update?api_key="; // prepare GET string
getStr += apiKey;
getStr +="&field1=";
getStr += String(value1);
getStr +="&field2=";
getStr += String(value2);
getStr +="&field3=";
getStr += String(value3);
getStr +="&field4=";
getStr += String(value4);
getStr +="&field5=";
getStr += String(value5);   // ...
getStr += "\r\n\r\n";

  // send data length
cmd = "AT+CIPSEND=";
cmd += String(getStr.length());
espSerial.println(cmd);
if (DEBUG)
Serial.println(cmd);
delay(100);
if(espSerial.find(">"))
{ espSerial.print(getStr); if
(DEBUG)
Serial.print(getStr);
 }
else
{
espSerial.println("AT+CIPCLOSE"); // alert user if
(DEBUG)
Serial.println("AT+CIPCLOSE");
 return false;
  }
  return true; }


//========= // setup || //=========

void setup()
{
DEBUG=true;          // enable debug serial
Serial.begin(9600);
```

```
espSerial.begin(115200);
espSerial.println("AT+RST");
showResponse(1000);

  espSerial.println("AT+UART_CUR=9600,8,1,0,0");
showResponse(1000);

  espSerial.println("AT+CWMODE=1");   // set esp8266 as client
showResponse(1000);
 espSerial.println("AT+CWJAP=\""+ssid+"\",\""+password+"\"");   //set your home router SSID
and password
showResponse(5000);

if (DEBUG)
Serial.println("Setup completed"); }

// ======= // loop || // =======

void loop()  {

  // Read sensor values
float temp=0.0, humi=0.0;
int err;
int airquality_value = analogRead(airquality_sensor_pin);
int gas_value = analogRead(gas_sensor_pin);
 int moisture = analogRead(VAL_PROBE);
if((err=dht11.read(humi, temp))!=0)
{ Serial.println();
Serial.print("Error No
:"); Serial.print(err);
Serial.println();
  }
Serial.println();
Serial.print("temperature:");
Serial.print(temp);
Serial.println(); Serial.print("
humidity:"); Serial.print(humi);
Serial.println(); Serial.print("Gas
Value:> "); Serial.print(gas_value);
Serial.println(); Serial.print("Air
Quality Value:> ");
Serial.print(airquality_value);
Serial.println();


Serial.print("Soil Moisture Value:> ");
```

```
Serial.println(1000-moisture);
Serial.println("% send to Thingspeak");
Serial.println();
 Serial.print("________________________________________\n");
delay(1000);
thingSpeakWrite(temp,humi,gas_value,airquality_value,moisture);    // Write values to thingspeak
// thingspeak needs 15 sec delay between updates,
delay(20000); }
```

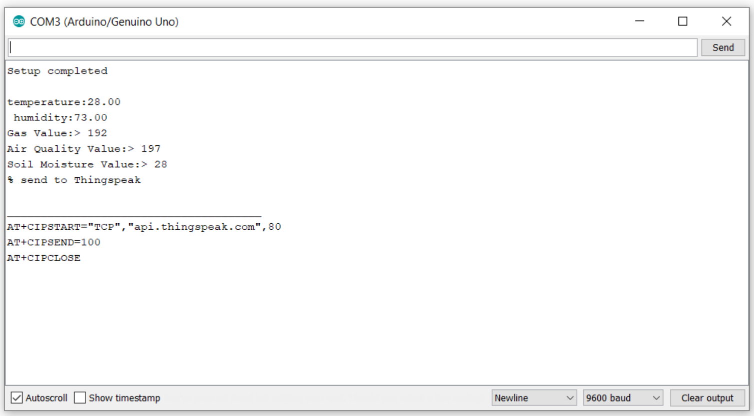
Serial Monitor Window(s) –

Initial Output:

Arduino IDE Window with Serial Monitor Window:

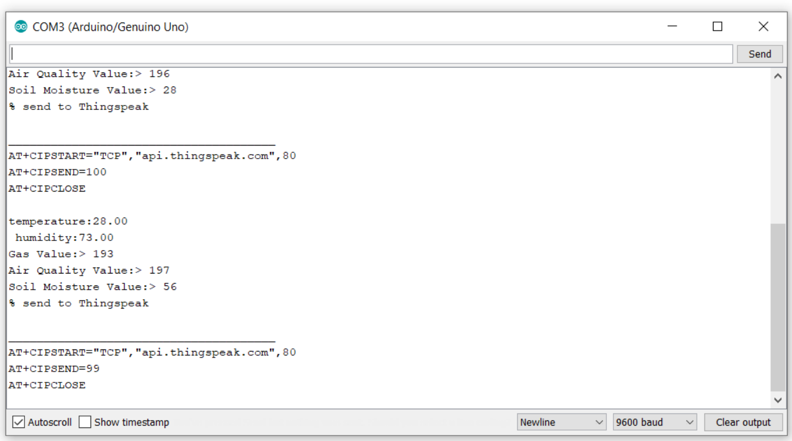
Dry Soil

```
  // Read sensor values
float temp=0.0, humi=0.0;
int err;
int airquality_value = analogRead(airquality_sensor_pin);
int gas_value = analogRead(gas_sensor_pin);
 int moisture = analogRead(VAL_PROBE);
if((err=dht11.read(humi, temp))!=0)
{              Serial.println();
Serial.print("Error No :");
Serial.print(err);
Serial.println();
  }
Serial.println();
Serial.print("temperature:");
Serial.print(temp);
Serial.println();
Serial.print(" humidity:");
Serial.print(humi);
Serial.println();
Serial.print("Gas Value:> ");
Serial.print(gas_value);
Serial.println();
Serial.print("Air Quality Value:> ");
Serial.print(airquality_value);
Serial.println();
Serial.print("Soil Moisture Value:> ");
Serial.println(1050-moisture);
Serial.println("% send to Thingspeak");
Serial.println();
 Serial.print("________________________________________\n");
```

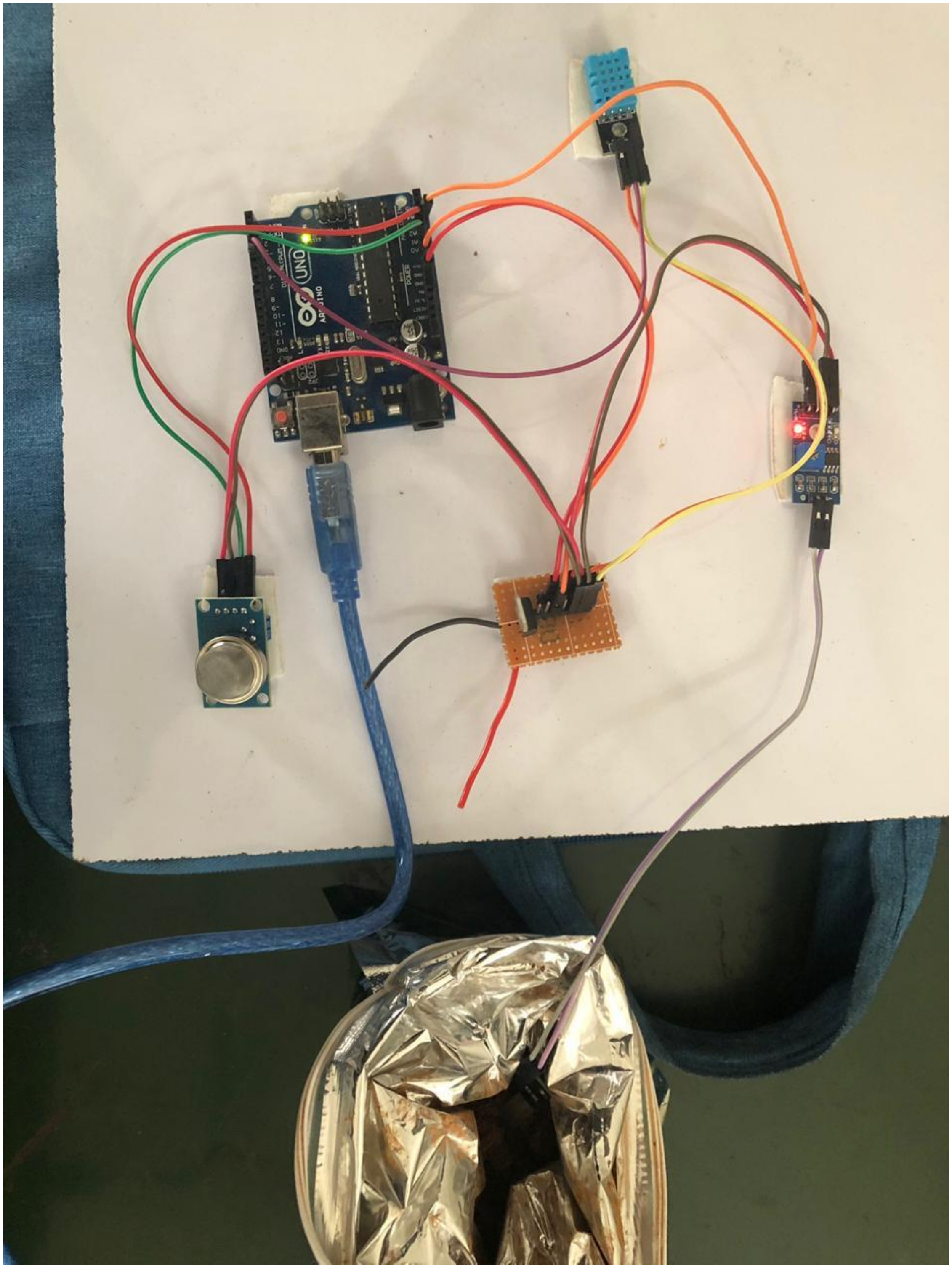


Moistened Soil

```
  // Read sensor values
float temp=0.0, humi=0.0;
int err;
int airquality_value = analogRead(airquality_sensor_pin);
int gas_value = analogRead(gas_sensor_pin);
 int moisture = analogRead(VAL_PROBE);
if((err=dht11.read(humi, temp))!=0)
{              Serial.println();
Serial.print("Error No :");
Serial.print(err);
Serial.println();
  }
Serial.println();
Serial.print("temperature:");
Serial.print(temp);
Serial.println();
Serial.print(" humidity:");
Serial.print(humi);
Serial.println();
Serial.print("Gas Value:> ");
Serial.print(gas_value);
Serial.println();
Serial.print("Air Quality Value:> ");
Serial.print(airquality_value);
Serial.println();
Serial.print("Soil Moisture Value:> ");
Serial.println(1050-moisture);
Serial.println("% send to Thingspeak");
Serial.println();
 Serial.print("________________________________________\n");
delay(1000);
thingSpeakWrite(temp,humi,gas_value,airquality_value,moisture);      // Write values to thingspeak      // thingspeak needs 15 sec delay between updates,
delay(20000);   }
```



CONNECTIONS:



10.CONCLUSION

We successfully concluded that this model accurately provides the value for all the pre-requisite values required for higher yield of agriculture production. All observations and experimental tests prove that project is a complete solution to field activities, irrigation problems of smart agricultural system. Implementation of such a system in the field can definitely help to improve the yield of the crops and overall production

11.FUTURE OPPORTUNITIES

The results we obtained can also be presented in a graphical format. We can compare it and monitor our crops and their required nutrient content and all other factors that affect its production and growth and which can be altered to optimize it. So, if this project is implemented properly in the fields it can very well help the farmer to monitor the conditions that would affect thegrowth and production of his/her crops and increase the yield.

12. REFERENCES

1. *TongKe, Fan. "Smart Agriculture Based on Cloud Computing and IOT." Journal of Convergence Information Technology 8, no. 2 ,2013.*
2. *Zhao, Ji-chun, Jun-feng Zhang, Yu Feng, and Jian-xin Guo. "The study and application of the IOT technology in agriculture." In Computer Science and Information Technology ICCSIT, 2010 3rd IEEE International Conference on, vol. 2, pp. 462-465. IEEE, 2010.*
3. *Agrawal, Sarita, and Manik Lal Das. "Internet of Things—A paradigm shift of future Internet applications." In Engineering (NUiCONE), 2011 Nirma University International Conference on, pp.1-7. IEEE, 2011.*
4. *Chen, Xian-Yi, and Zhi-Gang Jin. "Research on key technology and applications for internet of things." Physics Procedia 33, pp. 561-566, 2011.*
5. *Li, Li, Hu Xiaoguang, Chen Ke, and He Ketai. "The applications of WiFi-based wireless sensor network in internet of things and smart grid." In Industrial Electronics and Applications ICIEA, 2011 6th IEEE Conference on, pp. 789-793. IEEE, 2011.*
6. *Talpur, Mir Sajjad Hussain, Murtaza Hussain Shaikh, and Hira Sajjad Talpur. "Relevance of Internet of Things in Animal Stocks Chain Management in Pakistan's Perspectives." International Journal of Information and Education Technology 2, no. 1 ,2012.*
7. *Evangelos A, Kosmatos, Tselikas Nikolaos D, and Boucouvalas Anthony C. "Integrating RFIDs and smart objects into a UnifiedInternet of Things architecture." Advances in Internet of Things 2011 ,2011.*
8. *Carvin, Denis, Philippe Owezarski, and Pascal Berthou. "Managing the upcoming ubiquitous computing." In Proceedings of the 8th International Conference on Network and Service Management, pp. 1276-280. International Federation for Information Processing, 2012.*
9. *Prasad, Rajkishore, Kumar Rajeev Ranjan, and A. K. Sinha. "AMRAPALIKA: An expert system for the diagnosis of pests, diseases, and disorders in Indian mango." Knowledge-Based Systems, Vol. 19, no. 1,pp. 9-21,2006.*
10. *P.Panigrahi, R.K.Sharma, M.Hasan, S.S.Parihar, "Deficit irrigation scheduling and yield prediction of 'Kinnow'mandarin(Citrus reticulate Blanco) in a semiarid region" Agricultural Water Management journal Elsevier 21 march 2014.*