A PROJECT REPORT

ON

SMART AGRICULTURE

Submitted to

KIIT Deemed to be University

By:

BEDABRATA BORA- 1706123

PRIYANKA RAJ- 1706145

SATYAM SHAH- 1706157

SHASHWATA MUKHERJEE- 1706160

ADITYA GUPTA- 1705479

PRAKHAR AWASTHI- 1705516

UNDER THE GUIDANCE OF

PROF. PAO-ANN HSIUNG

NATIONAL CHUNG CHENG UNIVERSITY

SCHOOL OF COMPUTER ENGINEERING
KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY
BHUBANESWAR, ODISHA – 751024
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Shashwata Mukherjee

Bedabrata Bora

Satyam Shah

Priyanka Raj

Prakhar Awasthi

Aditya Gupta

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 of this project is to provide an IoT based Smart Farming System solution, 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. The IoT based Smart Farming System being proposed via this report is integrated with Arduino Technology mixed with different Sensors and a Wifi module producing live data feed that can be obtained online from Firebase. The product being proposed is tested on Live Agriculture Fields giving high accuracy over 86% in data feeds.

CONTRIBUTION

SL NO	NAME	ROLL NO	E-mail ID	DESIGNATION
1	BEDABRATA BORA	1706123	1706123@kiit.ac.in	Android App
2	PRIYANKA RAJ	1706145	1706145@kiit.ac.in	IoT
3	SATYAM SHAH	1706157	1706157@kiit.ac.in	Cloud
4	SHASHWATA MUKHERJEE	1706160	1706160@kiit.ac.in	Documentation
5	PRAKHAR AWASTHI	1705516	1705516@kiit.ac.in	Machine Learning
6	ADITYA GUPTA	1705479	1705479@kiit.ac.in	Machine Learning

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1. PROJECT DETAILS

1.1 Problem Statement

Nowadays Farmers are dependent on rain and Boring well to irrigate their lands. They need to turn ON/OFF water pump manually but before they have to check whether the soil needs watering or not. This process is time consuming because they have to check the soil manually in regular intervals otherwise the corps can get damage because of failure of water supply.

1.2 Solution

We can automate the whole process with help of IOT by Monitoring environmental factors like temperature, humidity and soil moisture. Sensors can be used to collect these data and by using these data, we can turn ON/OFF motor automatically without the farmer intervention.

2. INTRODUCTION

2.1 Overview

Internet of Things (IoT) plays a crucial role in smart agriculture. Smart farming is an emerging concept, because IoT sensors capable of providing information about their agriculture fields. The collected data are analysed by experts and local farmers to draw suitable conclusion on the various things that will be required for next week to a month etc. We can take smart farming a step further by automating several parts of farming, for example, smart irrigation and water management. We can apply predictive algorithms on micro-controllers or SoC to calculate the amount of water that will be required today for a particular agriculture field. Say, if there was rain yesterday and the quantity of water required today is going to be less. Similarly if humidity was high the evaporation of water at upper ground level is going to be less, so water required will be less than normal, thus reducing water usage. The project aims making use of evolving technology i.e. IoT and smart agriculture using automation. The feature of this project includes monitoring temperature, humidity and moisture in agricultural field. It will turn ON/OFF motor on the basis of favourable condition.

2.2 OBJECTIVE

In agriculture sector, one of the most important factor for the healthy growth of crops is irrigation. The objective of this project is to propose and IoT based Smart Farming System which will enable farmers to have live data of soil moisture environment temperature at very low cost so that live monitoring can be done. We make use of ML to automate the irrigation process to reduce labour cost for the farmers.

2.3 IOT TECHNOLOGY AND AGRICULTURE

With the adoption of IoT in various areas like Industry, Homes and even Cities, huge potential is seen to make everything Intelligent and Smart. Even the Agricultural sector is also adopting IoT technology these days and this in turn has led to the development of “AGRICULTURAL Internet of Things (IoT)”

Table 1.1 Various projects and applications are integrated in Agricultural fields leading to efficient management and controlling of various activities.

Application Name	Description
Crop Water Management	In order to perform agriculture activities in inefficient manner, adequate water is essential. Agriculture IoT is integrated with Web Map Service (WMS) and Sensor Observation Service (SOS) to ensure proper water management for irrigation and in turn reduces water wastage.
Precision Agriculture	High accuracy is required is required in terms of weather information which reduces the chances of crop damage. Agriculture IoT ensures timely delivery of real time data in terms of weather forecasting, quality of soil, cost of labour and much more to farmer.
Integraratted Pest Management or Control (IPM/C)	Agriculture IoT systems assures farmers with accurate environmental data via proper live data monitoring of temperature , moisture, plant growth and level of pests so that proper care can be taken during production
Food Production & Safety	Agriculture IoT system accurately monitors various parameters like warehouse temperature, shipping transportation management system and also integrates cloud based recording systems.
Other Projects Implemented Till Date	1. The Phenonet Project by Open IoT. 2. CLASS Equipment 3. Precisionhalk’s UAV Sensor Platform 4. Cleangrow’s Carbon Nanotube Probe 5. Temputech’s Wireless Sensor Monitoring .

2.3.1 BENEFITS OF IOT IN AGRICULTURE

The following are the benefits of IoT in Agriculture:

1. IoT enables easy collection and management of tons of data collected from sensors and with integration of cloud computing services like agriculture fields maps, cloud storage etc., data can be accessed live from anywhere and everywhere enabling live monitoring and end to end connectivity among all the parties concerned.
2. IoT is regarded as key component for Smart Farming as with accurate sensors and smart equipment's, farmers can increase the food production by 70% till year 2050 as depicted by experts.
3. With IoT, production costs can be reduced to a remarkable level which will in turn increase profitability and sustainability.
4. With IoT, efficiency level would increase in terms of usage of soil, water, fertilizers.

3. COMPONENTS

In this section, various components and Modules being used for IoT based Smart Agriculture System development is discussed:

3.1 Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins(of which 6 can be used as PWM outputs),6 analogue inputs, a 16 MHz crystal oscillator, a USB connection ,a power jack, an ICSP header, and a reset button.

3.2 ESP-8266 Board

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by manufacturer Espressif Systems in Shanghai, China. ... This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands.

3.3 Sensors

3.3.1 Temperature and humidity sensor (DHT-22)

The DHT22 is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use, but requires careful timing to grab data.

3.3.2 Light Intensity Sensor

BH1750 module is a digital ambient light sensor, IIC I2C communication. Good for arduino light detection. It is a light intensity sensor breakout board with a 16 bit AD converter built-in which can directly output a digital signal, there is no need for complicated calculations. This is a more accurate and easier to use version of the simple LDR which only outputs a voltage that needs to be calculated in order to obtain meaningful data.

3.3.3 Soil Moisture Sensor

The Soil Moisture Sensor Module determines the amount of soil moisture by measuring the resistance between two metallic probes that is inserted into the soil to be monitored.

3.4 Firebase

We are using the firebase database to integrate the android app to register user with the system and sync the data, displayed to the user, with the database.

3.5 Android Studio

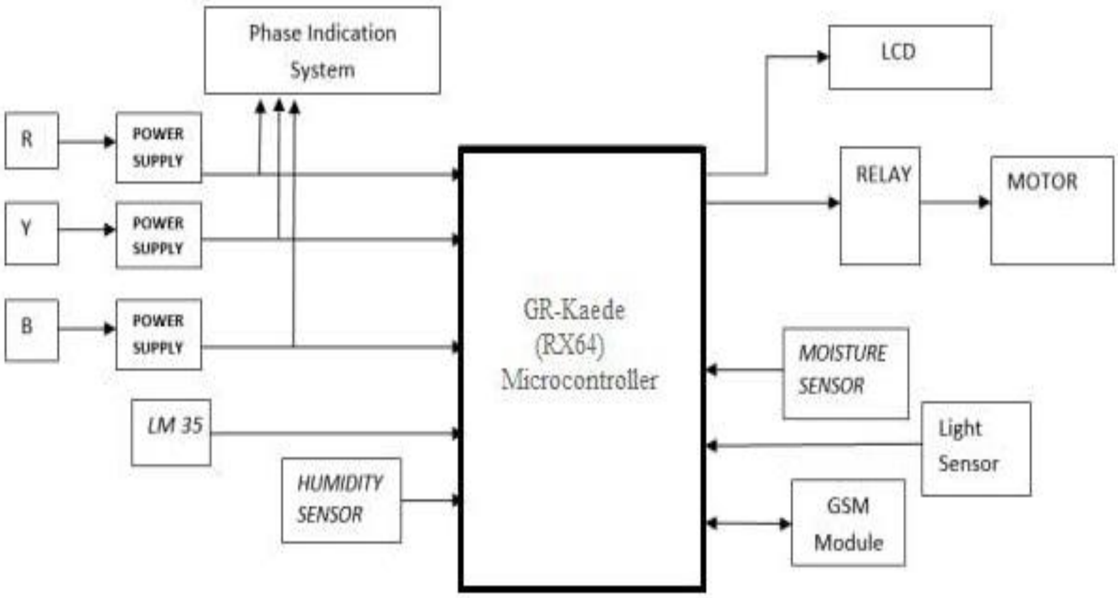
In this project, we use Android Studio for the app development process which would be very beneficial to the admin as he/she would get the necessary information about the users anywhere anytime irrespective of the presence of a PC/Laptop with him. The app version would be much mobile as compared to the computer systems.

3.6 I2C LCD Display

This is a 16x2 LCD display screen with I2C interface. It is able to display 16x2 characters on 2 lines, white characters on blue background.

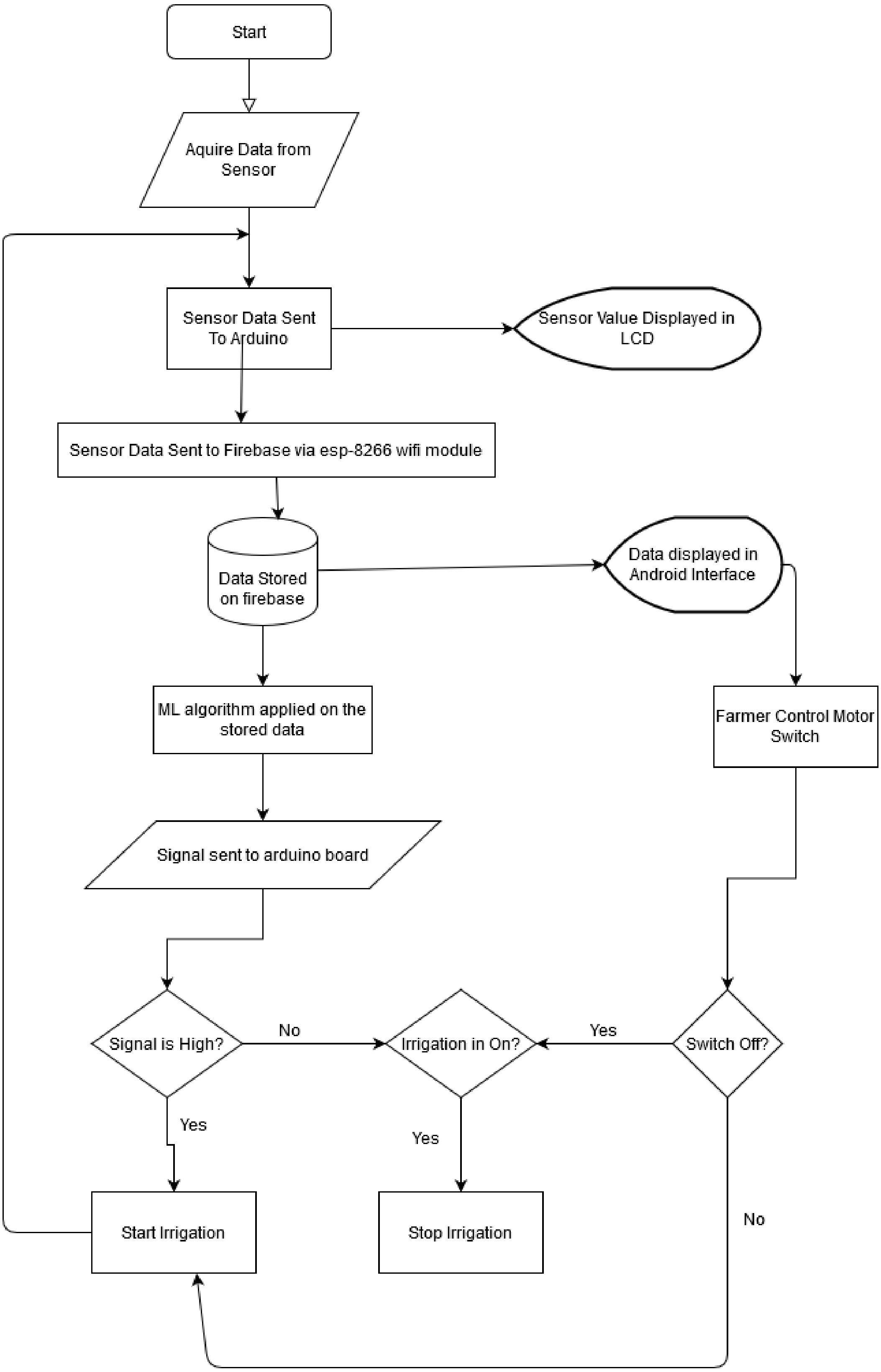
4. WORKING

4.1 Block Diagram



SMART AGRICULTURE SYSTEM

4.2 Flow Chart Diagram



4.3 Dataset Used

Humidity	Light	Temperature	Moisture
80	1000	37	6
79.5	987.5	36.65	6.05
79	975	36.3	6.1
78.5	962.5	35.95	6.15
78	950	35.6	6.2
77.5	937.5	35.25	6.25
77	925	34.9	6.3
76.5	912.5	34.55	6.35
76	900	34.2	6.4
75.5	887.5	33.85	6.45
75	875	33.5	6.5
74.5	862.5	33.15	6.55
74	850	32.8	6.6
73.5	837.5	32.45	6.65
73	825	32.1	6.7
72.5	812.5	31.75	6.75
72	800	31.4	6.8
71.5	787.5	31.05	6.85
71	775	30.7	6.9
70.5	762.5	30.35	6.95
70	750	30	7
69.5	737.5	29.65	7.05
69	725	29.3	7.1
68.5	712.5	28.95	7.15
68	700	28.6	7.2
67.5	687.5	28.25	7.25
67	675	27.9	7.3
66.5	662.5	27.55	7.35
66	650	27.2	7.4
65.5	637.5	26.85	7.45
65	625	26.5	7.5
64.5	612.5	26.15	7.55
64	600	25.8	7.6
63.5	587.5	25.45	7.65
63	575	25.1	7.7
62.5	562.5	24.75	7.75
62	550	24.4	7.8
61.5	537.5	24.05	7.85
61	525	23.7	7.9
60.5	512.5	23.35	7.95
60	500	23	8
72.6	815	31.85	6.73
67.7	690	28.35	7.23

61.7	540	24.6	7.82
77.6	940	35.35	6.22
70.2	755	30.12	6.99

4.4 Process

The sensors after collecting the data will send it to the Arduino uno board from where it will be sent to firebase with the esp-8266 wifi module. The data from the firebase was then imported to implement machine learning algorithm on it. Upon multiple linear regression on the dataset and feature scaling from a range between -1 to 1, we integrated a prediction model based on which the Arduino will receive signal from the cloud which will in turn switch the water motor on/off for the required duration. Also we implemented an android interface for the farmers to be able to monitor the moisture and temperature level and be able to switch on/off water motor remotely based on their preferences.

4.5 Code Snippets

4.5.1 Arduino Uno code

```
#include <dht.h>                              //DHT library
#include <SoftwareSerial.h>
#include <LiquidCrystal_I2C.h>                //LCD Library
SoftwareSerial mySerial(5, 6);              //Defininig serial port

LiquidCrystal_I2C lcd(0x27, 16, 2);
dht DHT;
#define DHT22PIN A3
int ack, soil, light;

void setup()
{
  Serial.begin(9600);
  mySerial.begin(115200);
  pinMode(A0, INPUT);                       //Input for light sensor
  pinMode(A1, INPUT);                       //Input for soil moisture sensor
  lcd.init();                               //Start led display
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("Please wait for");
  lcd.setCursor(0, 1);
  lcd.print("2 seconds.");
  delay(2000);
  lcd.clear();
}

void loop()
{
  ack = 0;
  int chk = DHT.read22(DHT22PIN);

  //-------------------------Check to see if dht is working-------------------------//
  switch (chk)
  {
    case DHTLIB_ERROR_CONNECT:
      ack = 1;
      break;
  }
  //--------------------------------------------------------------------------------//
  if (ack == 1)
  {
    Serial.print("NO DATA");
    Serial.print("\n\n");
    delay(2000);
  }
    light=analogRead(A1);                     //Reading light sensor data
    light=map(light, 0, 1023, 100, 0);

    soil=analogRead(A0);                     //Reading soil moisture data
```

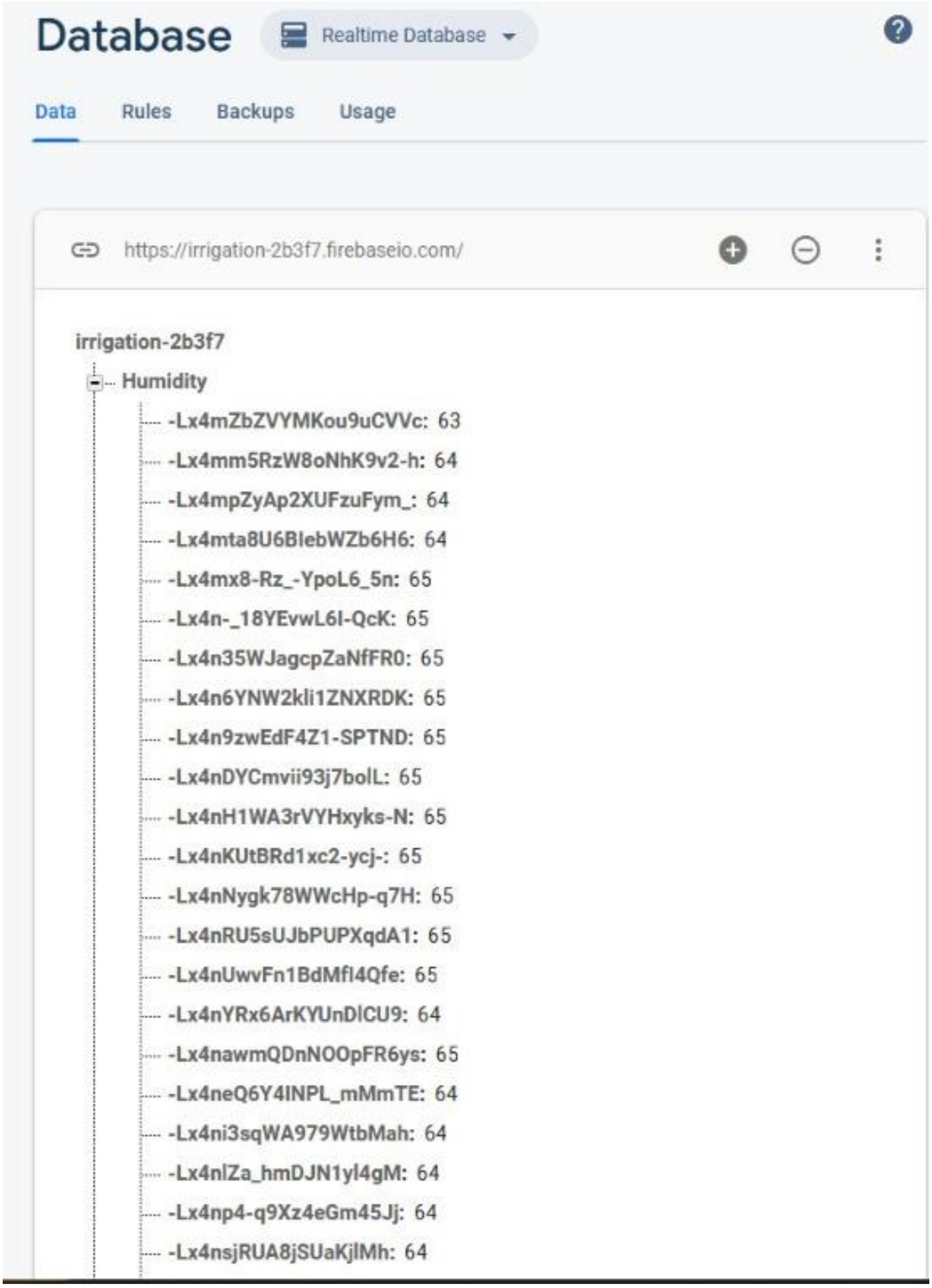
```
  lcd.clear();
  lcd.setCursor(0, 0);

  lcd.print("Soil:");                    //Display soil data
  lcd.print(soil);
  lcd.print("%");

  lcd.setCursor(0, 1);
  lcd.print("Light:");                     //Display Light intensity
  lcd.print(light);
  lcd.print("%");

  delay(3000);
  lcd.clear();

  lcd.setCursor(0, 0);                       //Display dht data
  lcd.print("Temp:");
  lcd.print(DHT.temperature);
  lcd.print(" *C");
  lcd.setCursor(0, 1);
  lcd.print("Humidity:");
  lcd.print(DHT.humidity);
  lcd.print("%");
  delay(3000);

 if (ack == 0)
 {
  Serial.print("Temperature(*C) = ");
  Serial.println(DHT.temperature, 0);
  Serial.print("Humidity(%) = ");
  Serial.println(DHT.humidity, 0);
  Serial.print("Soil(%) = ");
  Serial.println(soil);
  Serial.print("Light = ");
  Serial.println(light);
  Serial.println("------------------------------");

  delay(1000);                        //Sending data at interval of 1 second

  //------------------Sending Data to ESP8266------------------//
  mySerial.print('*'); // Starting char
  mySerial.print(DHT.temperature, 0); //2 digit data
  mySerial.print(DHT.humidity, 0); //2 digit data
  mySerial.print(soil);             //2 digit data
  mySerial.print(light);            //2 digit data
  mySerial.println('#'); // Ending char*/
  //--------------------------------------------------------//
 }
}
```

4.5.2 ESP-8266 code

```
#include <ESP8266WiFi.h>
#include <FirebaseArduino.h>
#include <ArduinoJson.h>
#include <ESP8266HTTPClient.h>
#include <SoftwareSerial.h>

#define  ssid "Serbius"                                    // input your home or public wif:
#define password "..Password"
SoftwareSerial s(D6,D5);

int data1, data2, data3, data4;

String buff;
#define FIREBASE_HOST "irrigation-2b3f7.firebaseio.com"
#define FIREBASE_AUTH "b1uBhgnuEq5jmCIe1V5DcORGRlTEvEyRKTodKw2R"

int valueFromString(String string, int x, int y)
{
   int value=0;
   for(int n=0; n<y; n++)
   {
    value=value*10+string[x+n]-'0';
   }
   return value;
}

void setup()
{
  s.begin(115200);
  Serial.begin(115200);
  delay(10);
  WiFi.begin(ssid, password);                  //Connecting node to local wifi
  Serial.println();
  Serial.println();
  Serial.print("Connecting to ");
  Serial.println(ssid);
```

```
      buff = s.readString();
      if (buff[0] == '*')
      {
        if (buff[9] == '#')
        {
          Serial.println(buff);
          data1 =  valueFromString(buff,1,2);     //Reading 2 bit data
          data2 = valueFromString(buff,3,2);       //Reading 2 bit data
          data3 = valueFromString(buff,5,2);       //Reading 2 bit data
          data4 = valueFromString(buff,7,2);       //Reading 2 bit data
        }
      }
    }
  }
  //-------------------------------------------------------------------------------------//

  //----------------------------------------Debug--------------------------------------//
  Serial.println(data1);
  Serial.println(data2);
  Serial.println(data3);
  Serial.println(data4);

  //--------------------------Sending Data to FireBase----------------------------//
  delay(10000);
  Firebase.pushInt("Temperature",data1);
  Firebase.pushInt("Humidity",data2);
  Firebase.pushInt("Light",data3);
  Firebase.pushInt("Moisture",data4);
  if (Firebase.failed()) // Check for errors
  {
    Serial.print("setting /number failed:");
    Serial.println(Firebase.error());
    return;}
  //----------------------------------------------------------------------------------//
  Serial.println("Waiting...");
  delay(2000);
}
```

4.5.3 Firebase database



4.5.4 Machine Learning code

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd

# Importing the dataset

dataset = pd.read_csv("IOTPROJECT.csv")
X = dataset.iloc[:,:-1]
Y = dataset.iloc[:,3]


# Splitting the dataset into test_set and train_set

from sklearn.model_selection import train_test_split
X_train,X_test,Y_train,Y_test = train_test_split(X,Y,test_size = 0.2)


# Feature Scaling

from sklearn.preprocessing import StandardScaler
sc_X = StandardScaler()
X_train = sc_X.fit_transform(X_train)
X_test = sc_X.transform(X_test)

#Fitting Simple Linear Regression in the dataset

from sklearn.linear_model import LinearRegression
regressor = LinearRegression()
regressor.fit(X_train,Y_train)
regressor.intercept_
regressor.coef_

#predicting the value for the dataset

pred=regressor.predict(X_test)
pred

#Checking the accuracy of the predicted Model

from sklearn.metrics import r2_score as r2
q1=r2(Y_test,pred)
q1
```

```python
#Predicting the moisture content on the basis of user interface input

T=[]
Moist=0.0
print("Enter the values of humidity(70-80), light(755-1000) and temperature(30-40) ")
for i in range(1,4):
    T.append(float(input()))
Moist=float(input("Enter the current moisture level : "))
T = sc_X.transform([T])
Y_pred = regressor.predict(T)
print("\nThe amount of water required is {} units.".format(Y_pred))
if(Y_pred[0] > Moist):
    print("Motor turned on.")
elif(Y_pred[0] < Moist):
    print("Excess moisture in the soil.")
else:
    print("Moisture just right.")



#Visualizing the Training set results

Z = X_train[:,1:2]
plt.scatter(Z,Y_train,color="Red")
plt.plot(Z,regressor.predict(X_train),color="Blue")
plt.title("Light vs Moisture (Training set)")
plt.xlabel("Light")
plt.ylabel("Moisture")
plt.show()

#Visualizing the Test set results

Z = X_test[:,1:2]
plt.scatter(Z,Y_test,color="Red")
plt.plot(Z,regressor.predict(X_test),color="Blue")
plt.title("Light vs Moisture (Test set)")
plt.xlabel("Light")
plt.ylabel("Moisture")
plt.show()
```

5. SUMMARY

Measuring soil moisture is important in agriculture to help farmers manage their irrigation systems more efficiently. Not only are farmers able to generally use less water to grow a crop, they are able to increase yields and the quality of the crop by better management of soil moisture during critical plant growth stages. Embedded system for automatic irrigation of an agriculture field offers a potential solution to support site specific irrigation management that allows producers to maximize their productivity while saving the water. The proposed technique has many advantages like:

- Reducing risk of electric shocks, deaths due to poisonous creatures in the fields.
- Visual display using LCD display unit.
- Watering depends on the moisture level present in the field.
- All the farm parameters can view through online in graphical notation.
- Efficient and low cost design.
- Fast response.
- User friendly.

6. CONCLUSION

Thus, this system avoids over irrigation, under irrigation, top soil erosion and reduce the wastage of water. The main advantage is that the system's action can be changed according to the situation (crops, weather conditions, soil etc.). By implementing this system, agricultural, horticultural lands, parks, gardens, golf courses can be irrigated. Thus, this system is cheaper and efficient when compared to other type of automation system. In large scale applications, high sensitivity sensors can be implemented for large areas of agricultural lands

7. FUTURE SCOPE

For the fore coming days, we have an idea to monitor the water pressure level with flow level and above discussed details can be displayed in the Web Portal and intimate in Twitter.