VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELGAUM - 590014

A Project Report
On

Automatic Soil Parameters and Crop Detection Management System Using IOT

A Project report submitted in partial fulfillment of the requirements for the VIII Semester degree of
Bachelor of Engineering in Computer Science and Technology
of Visvesvaraya Technological University, Belgaum

Submitted by:

SONAL UDAPUDI (1DT17CS094)

SONIKA R (1DT17CS095)

ARAVIND E M (1DT18CS402)

PRASAD SHIVAM (1DT16CS066)

Under the Guidance of:

Prof. Anoop G L

(Assistant Prof, Dept of CSE)

Department of Computer Science and Engineering

DAYANANDA SAGAR ACADEMY OF TECHNOLOGY AND MANAGEMENT

Kanakapura Road, Udayapura, Bangalore

2020-2021

DAYANANDA SAGAR ACADEMY OF TECHNOLOGY AND MANAGEMENT

(Affilated to Visvesvaraya Technological University, Belagavi & Approved by AICTE, New Delhi)
Opp. To Art of Living International Centre, Kanakpura Road, Udayapura, Bangalore-560082

Department of Computer Science and Engineering

Accredited 3 years by NBA, New Delhi (Validity : 26-07-2018 to 30-06-2021)

CERTIFICATE

Certified that the project work entitled **Automatic Soil Parameters and Crop Detection Management System using IOT** carried out by **SONAL UDAPUDI (1DT17CS094), SONIKA R (1DT17CS095), ARAVIND E M (1DT18CS402), and PRASAD SHIVAM (1DT16CS066)** bonafide students of **Dayananda Sagar Academy of Technology and Management** in partial fulfilment for the award of Bachelor of Engineering in **Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2020-21. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the Report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of Project work prescribed for the said Degree.

Signature of the Guide	Signature of the Coordinator	Signature of the HOD
Prof. Anoop G L	Dr. Saravanakumar R	Dr. Nandini C
Assistant Professor	Associate Professor	Vice Principal & HOD
Dept. of CSE	Dept. of CSE	DSATM

Name of the external examiners **Signature with date**

1.
2.

DECLARATION

We, **SONAL UDAPUDI [USN:1DT17CS094], SONIKA R [USN:1DT17CS095], ARAVIND E M [USN:1DT18CS402] and PRASAD SHIVAM [USN:1DT16CS066]**, students of VIII Semester BE, in Computer Science and Engineering, Dayananda Sagar Academy of Technology & Management hereby declare that the Project entitled "**Automatic Soil Parameters and Crop Detection Management System using IOT**" has been carried out by us and submitted in partial fulfillment of the requirements for the VIII Semester degree of ***Bachelor of Engineering in Computer Science and Engineering*** *of Visvesvaraya Technological University, Belgaum* during academic year 2020-2021.

Date:

Place: Bengaluru

SONAL UDAPUDI	**(1DT17CS094)**
SONIKA R	**(1DT17CS095)**
ARAVIND E M	**(1DT18CS402)**
PRASAD SHIVAM	**(1DT16CS066)**

ACKNOWLEDGEMENT

We express our appreciation for **Dr. B. R. Lakshmikantha**, **Principal**, DSATM, Bangalore, in providing necessary facilities and for encouragement to carry out the Project.

We express our humble gratitude and thanks to **Dr. C. Nandini**, **Professor and HOD**, Computer Science and Engineering, DSATM for guiding us and having facilitated us to complete the Project successfully.

We are very thankful to our guide **Prof. Anoop G L**, Department of Computer Science and Engineering**,** DSATM for her constant encouragement, guidance and support throughout the course of the Project without whose efforts this would not have been possible.

We thank the Project Coordinators **Dr. C. Kavitha, Professor & Dr. SarvanaKumar**, Professor, Department of Computer Science & Engineering, DSATM, Bengaluru for her invaluable critical reviews, guidance and support.

We finally thank our project team and friends who have been encouraging constantly and inspiring throughout.

SONAL UDAPUDI (1DT17CS094)

SONIKA R (1DT17CS095)

ARAVIND E M (1DT18CS402)

PRASAD SHIVAM (1DT16CS066)

ABSTRACT

As the world is trending into new technologies and implementations it is a necessary goal to trend up with agriculture also. IOT plays a very important role in smart agriculture. IOT sensors are capable of providing information about agriculture fields. we have proposed an IOT and smart agriculture system using automation. This IOT based Agriculture monitoring system makes use of wireless sensor networks that collects data from different sensors deployed at various nodes and sends it through the wireless protocol. This smart agriculture using IOT system is powered by Arduino, it consists of Temperature sensor, Moisture sensor, water level sensor, DC motor and GPRS module. This all is displayed on the LCD display module is played on the LCD display module. This all is also seen in IOT where it shows information of Humidity, Moisture and water level with date and time, based on per minute, based on this information the crop detection takes place.

Crop diseases are generally caused by pests, insects, pathogens, and have an adverse effect on the yield of the crop, amounting towards decrease in productivity of the crop. Farmers across the country are facing severe losses due to various crop diseases, and one of the main reasons preventing them from arriving at a solution is not being able to detect the disease at an early stage. To overcome this problem, we are proposing a Crop disease detect model using Machine Learning and IoT the proposed project is to develop a product which detects crop disease even from a remote area. As of now, due to lack of proper knowledge, farmers in remote places face a lot of problems in early detection of plant diseases which go unnoticed most of the time and cause severe problems.

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Chapter 1

INTRODUCTION

Agriculture is an application of IoT that requires much attention. By using IoT in agriculture field, farmers can increase the production of the crop, reduce the decay of crops and reduce the cost of fertilizers and other resources by using it time to time. Resources (water, fertilizers and seeds) can be managed efficiently. Most of the farmers have small farm around the world. These farmers sometimes face the loss of crop, low yield, poor quality of crops etc. Traditional methods to investigate the crop and analysis of soil is time consuming process. With the help of IoT and decisions based on data, farmers can get the high rate of profit and fields can be used efficiently. This reduces the cost and improves the crop growth.

In today's period, modern methods and advance technologies are used to get accurate results and time consumption are also very less. So, to resolve this problem, we have come up with a proposed model that will help the farmers to measure the different parameters of the soil like temperature of soil, humidity, climatic condition(rain) and moisture present in soil. All these data are collected and transferred to the cloud known as ThingSpeakCloud. Various Machine Learning algorithms are implemented on the collected data. After this process, analysis of data is done which are stored on ThingSpeakCloud and after getting the results, decisions are taken that which crop will be suitable for that particular environment where farmers will irrigate the crops. Farmers can analysis and see the result of parameters using ThingSpeakApplications.

1.1 Problem Statement

Our challenging task is to ensure sustainable soil productivity while maintaining high crop yields and reducing environmental pollution. To this end, the implementation of sensor technologies for soil nutrient management and monitoring is a step in the right direction. So, a system is required which gets the data and predicts the environmental conditions and according to that inform the farmers about the type of crop. The proposed system takes the soil sample as the input and performs the chemical reactions, corresponding changes in the color of sample is sensed by color sensors and decoded by colorimetry technique.

1.2 Objective

Our goal is to setup a system for proper utilization of fertilizers that protects the agricultural field and increases the crop productivity. For healthy growth and development of the plants and crops our system will increase the organic matter and nutrients to an adequate amount accordingly. Also, it will provide adequate amount of nutrients to plants and crops by statistical analysis collected from different climatic conditions, soil nutrients and environment conditions. In brief for better cultivation of crops to the farmers irrespective of climate, soil and environmental conditions.

1.3 Applications of Automatic Soil Parameters and Crop Detection Management System using IOT

Internet of Things (IoT) device is every object that can be controlled through the internet. IoT devices become pretty popular in consumer markets with wearable IoWT(Internet of Wearable Things) such as smartwatches and home management products like Google Home.

The applications of IoT in farming target conventional farming operations to meet the increasing demands and decrease production loses. IoT in agriculture uses remote sensors, computing images combined with continuously progressing machine learning and analytical tools for monitoring crops, surveying and mapping the fields and provide data to farmers for rational farm management plans to save both time and money.

1.4 Outline of Report

Starting with the Introduction to applications of automatic soil nutrients and crop detection management System and we have included the Literature Survey. The proposed methodologies are mentioned thereof. The software requirements and the configuration of OpenCV for work space environment are clearly specified. The validation of project is proved with various test cases. The experimental results are shown along with the help of snapshots. The reportis concluded along with discussion and future works at the end.

Chapter 2

LITERATURE SURVEY

2.1 Paper title: Soil Moisture and Atmosphere Detection System Using IOT and Machine Learning (2019)

Authors – Rishika Anand, Kavita Sharma, Dimple Sethi, Pooja Gambhir

In this paper, a new model is proposed for real time soil and environment monitoring. Parameters (temperature, humidity, moisture content and rain) are monitored. Sensor values are stored in the ThingSpeak cloud and user can access those values by android app (ThingView). Data analysis can be done by using Hybrid algorithm (Machine Learning). On the basis of collected parameters appropriate decisions for crop predictions are made using hybrid machine learning algorithm. Deployment model is proposed in this paper. In the future, a greater number of parameters can be monitored. Application can be made to get visual and audible alert whenever there is any unfavorable condition.

2.2 Paper title: IOT Based Farming Recommendation System Using Soil Nutrient and Environmental Condition Detection

Authors – Arun Kumar, Abhishek Kumar, Akash De, Shashank Shekhar, Rohan Kumar Singh

This paper exhibits how exorbitant laboratory soil test can be brought to reasonable and cost-effective soil test using the kit. Considering all possibilities of error occurrence, the kit has been built and the system has been coded and tested with great attention to detail. The proposed system has taken the soil sample as the input and performed the chemical reactions using reagents. The corresponding changes in the color of the sample have been sensed by the color sensors and decoded by colorimetry technique. Soil moisture sensor and temperature sensor have also been used to check the moisture level and temperature. A GPS has been used to get the location of the field so that the weather forecast can be fetched from the nearest weather station. Arduino Mega 2560 interfaced with Wi-Fi microchip ESP8266 has been used to get the data from the sensors and to send those data to cloud. An android application has been built to show the test report and recommendations. The study has suggested that rather than relying on time consuming laboratory soil reports, the user can have alternative means of checking the soil reports using portable IoT - cloud based soil kit. Furthermore, chemicals and sensors have been used in the system instead of electrochemical sensors to make it affordable for the end users. Also, the special designing of the proposed kit has increased the sustainability of the system.

2.2 Paper title: Automatic Soil Nutrients Detection and Fertilizer Dispensary System

Authors – Amrutha A, Lekha R, A Sreedevi

While the time taken for soil testing by chemical methods in a laboratory takes a few days, in the proposed system the results are obtained within 30 minutes. The results obtained from the soil test are fed to sensors and the results are analyzed using a microcontroller which in turn needs a few seconds. Hence, whole process of soil testing for all the measurement of the macronutrients requires a maximum 30-40 minutes after which the field can be fertilized. From the above results, it can be seen that the proposed system addresses the issues faced by farmers. The system determines the available NPK nutrients in the soil, estimates the fertilizers to be added. In addition, it automates the process of addition of fertilizers thereby reducing the time and manual labor required. The complete algorithm for the estimation of nutrients in the soil and control of fertilizer addition to the soil has been designed and implemented. However, the system is a prototype as the containers to hold the fertilizers are small. If the system is to be scaled for use in larger farms, containers of appropriate size are to be designed with a capacity of a few quintals.

2.3 Paper title: Monitoring of Soil Nutrients using IOT for Optimizing the Use of Fertilizers

Authors – Sujatha Anand, Silviya Catherine, Shanmuga Priya.S, A.Sweatha

Smart agricultural system can prove to be helpful for farmers. But In the present situation it has been realized that the use of inorganic fertilizers should be integrated with renewable and environmental friendly organic fertilizers and green manures.

But In the present situation it has been realized that the use of inorganic fertilizers should be integrated with renewable and environmental friendly organic fertilizers and green manures. Sensor network and their usage in farm monitoring is the most useful innovation for the people of INDIA. In smart farming, there is need to increase the productivity with decrease in cost, time and human effort. In this paper we use IOT sensor and cloud to monitor the soil nutrient, intrusions for the betterment of agricultural yield. As outcome of challenge, soil nutrient, animal and human intrusion if occurred in the field are monitored

2.4 Paper title: Nutrients Detection in the Soil

Authors - Ashwini A. Chitragar, Sneha M. Vasi, Sujata Naduvinamani, Akshata J. Katigar and Taradevi I. Hulasogi

Growing concern about environmental pollution by excessive use of fertilizers lead to increases in needs to monitor soil nutrients required for crop growth. The sensor network technology will help the farmers to know the soil requirements which will help them take better decisions and preventive measures at the right time. This will lead to tremendous improvement in the crop productivity. This, intern, will save their time, labor, money and make effective use of resources.

Chapter 3

REQUIREMENTS

The requirements can be broken down into 2 major categories namely hardware and software requirements. The former specifies the minimal hardware facilities expected in a system in which the project has to be run. The latter specifies the essential software needed to build and run the project.

2.1 Hardware Requirements

The Hardware requirements are very minimal and the program can be run on most of the machines.

- Processor - Intel Pentium processor or better
- Processor Speed - 500 MHz or above
- Hard Disk - 40GB (approx.)
- RAM - 512MB or above
- Storage Spacey - Approx. 4MB
- GPU - 2GB or higher
- Sensor - temperature, humidity sensor, soil moisture sensor, light Sensor(ldr) and gas sensor

2.2 Software Requirements

- Operating System : Windows
- Libraries : OpenCV
- Language Used : Python
- Packages Used : cv2, NumPy
- Software : Anaconda

Chapter 4

METHODOLOGY

A system is developed to maximize the agriculture yield by nutrient analysis.

The salient features of proposed system are:

- Is a real-time soil nutrient analysis system.
- Ability to measure current soil nutrients – Nitrogen, Phosphorus, and Potassium (NPK) values using sensor at the field eliminating the need to carry the soil to the lab.
- Database consisting of soil nutrients (NPK) for various crops including vegetables, fruits, etc.
- For any desired crop, calculate and suggest fertilizers to bring the level of nutrients in the soil to the ideal nutrient values for higher crop yield.
- Provides a user-friendly mobile application to display and access soil information and suggested fertilizers.

4.1 PROPOSED SYSTEM

The sensors used in this system are temperature, color, moisture and rain. These sensors are attached with node MCU microcontroller and that node MCU microcontroller is attached with cloud storage that is ThingSpeak with help of Wi-Fi. The data received from the cloud is examined through android application. The crop growth depends on the environment conditions. This system is proposed to help farmers to get the data from sensor and grow the crops accordingly.

4.1.1 Soil moisture sensor:

The soil moisture sensor is used to detect the amount of water content in the irrigation area. This sensor is used to calculate how much water is in the soil and how much irrigation is required. The water content of the soil is very important because it consists of nutrients that are necessary for the growth of plants. For plant growth, soil water is the best self- nutrient. The soil moisture is recognized using the FC28 sensor system. For measuring the water content in the soil, the FC28 unit is a simple eruption. The more water in the soil, the greater the conductivity between crops and the lower the resistance will result.

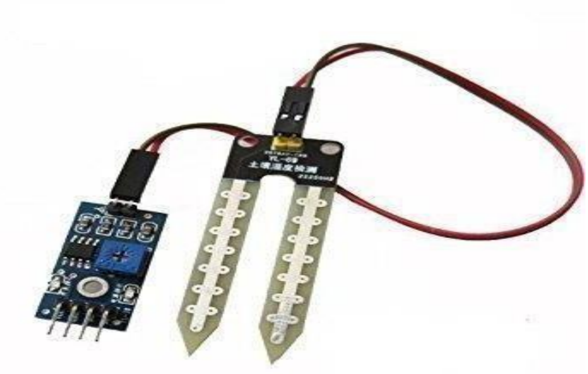

Figure 1: Soil Moisture Sensor

4.1.2 Temperature sensor:

The temperature sensor is designed to detect the humidity and temperature of the atmosphere in which our crops need to be grown. The DHT11 sensor system is used to detect the ambient environment's temperature and humidity. The humidity range should be between 20-80% and the temperature range should be between 0-50 ° C. This sensor uses a 'thin-film capacitive' humidity sensor and a 'thermistor' to test the ambient air.

Figure 2: DHT11 Temperature Sensor

4.1.3 Light sensor:

It is obvious that plants need good sun shine to prepare its own food and this process called photosynthesis. Plants need optimum amount of light not less or not too much. The amount of light received on a plot of land can be measured using LDR. The LDR changes its electrical resistance depending on amount of light incident on it. The amount of light is converted to 10-bit digital value and further converted to percentage out of 100. Zero means no light and 100% means a lot of light.

Figure 3: Light Sensor

4.1.4 Air Quality Sensor/Gas Sensor:

The quality of air needed for the plants is measured using gas sensor. So air quality is a very important parameter to judge the growth of crops, to do this we are using MQ 135 air quality sensor. When MQ 135 detects toxic gases the analog output value increases and vice versa. The analog output is converted into 10-bit digital value and converted to percentage out of 100.100% means lot of air contamination and 0% means least air contamination, so lower the value better the air quality.

Figure 4: MQ135 Gas Sensor

4.1.5 Microcontroller:

The Arduino Uno is an open source microcontroller board provides set of digital and analog input/output pins. It contains everything needed to support this IoT module. Using the board, it can simply connect to a computer and power source as well. There commended range is 5v to 12v for Arduino Uno. Multiple calibrated sensors are directly connected to it for measuring the soil and environmental parameters.

Figure 5: Arduino Uno

4.1.6 Architecture of Proposed Model:

All four sensors connect to Arduino Microcontroller. This Arduino connects via GSM Modem to ThingSpeak Cloud storage, which is an integrated module in the Arduino. Data on sensors is obtained from the Arduino and stored in the ThingSpeak Cloud. An application called ThingSpeak View is used to help farmers use their cell phones to search soil test results.

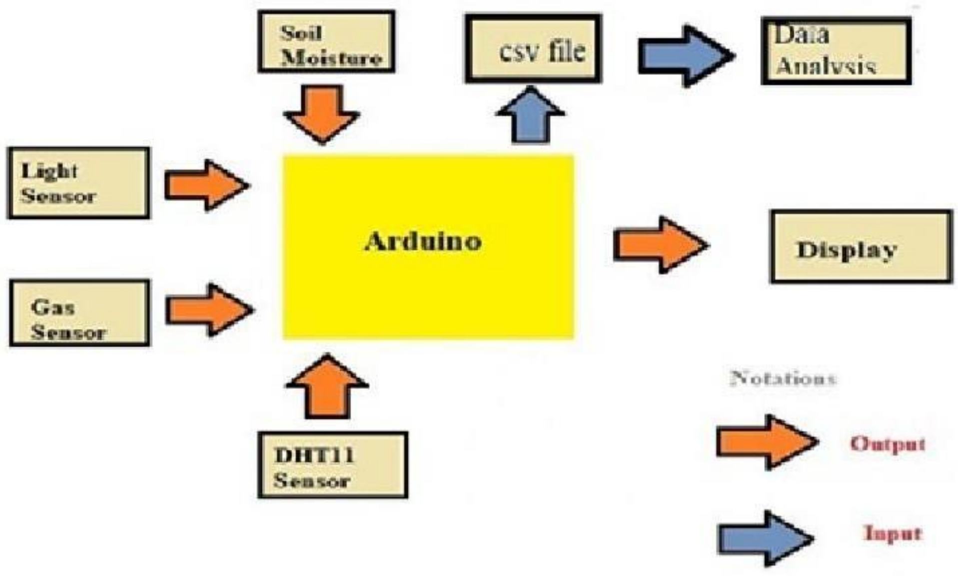

Figure 6: Block Diagram

4.2 Data Analysis

Optimized use of resources is mandatory nowadays in agriculture to fulfil the high rising demand of crop production with limited amount of minerals and resources. All the resources needed to put in the right way to obtain the best possible results. Doing agriculture without the proper analysis of soil may lead to wastage of time, money and land. There are various parameters that can affects the analysis part. In this research we have considered 4 parameters, to check whether the soil is suitable for crop production or not. These three parameters are: Temperature, Moisture, Humidity and status of rain. These four parameters play a very important role in the production of crops. As, crops require optimum temperature, moisture humidity and a proper amount of rain to grow. For all the above stated parameters plants have their optimum, minimal and maximal ranges for their production. Table shows three ranges of temperature for wheat and rice crop.

Table: Temperature Range for Wheat and Rice Crop

Crops --> Conditions	Wheat (Degree Celsius)	Rice (Degree Celsius)
Minimal	3-4	10-12
Optimal	25	30-32
Maximal	30-32	36-38

Analysis of collected data is the main motive of this research. Analysis part will include whether the parameters obtained from the sensors are suitable for plant growth or not. Once this is decided with the help of machine learning algorithms, we can predict that these parameters obtained from the sensors are suitable for which crop.

Chapter 5

IMPLEMENTATION

The proposed system is used to check different parameters. In this system all the data that are collected from the sensors are given to the microcontroller as an analog input. The collected data is analysed using machine learning. The real time data is collected and that data is transferred to the ThingSpeak cloud. With help of collected data and analysis result suitable crop is predicted.

IoT is an advanced technology that provides the capability to communicate the data over the network without any human intervention.

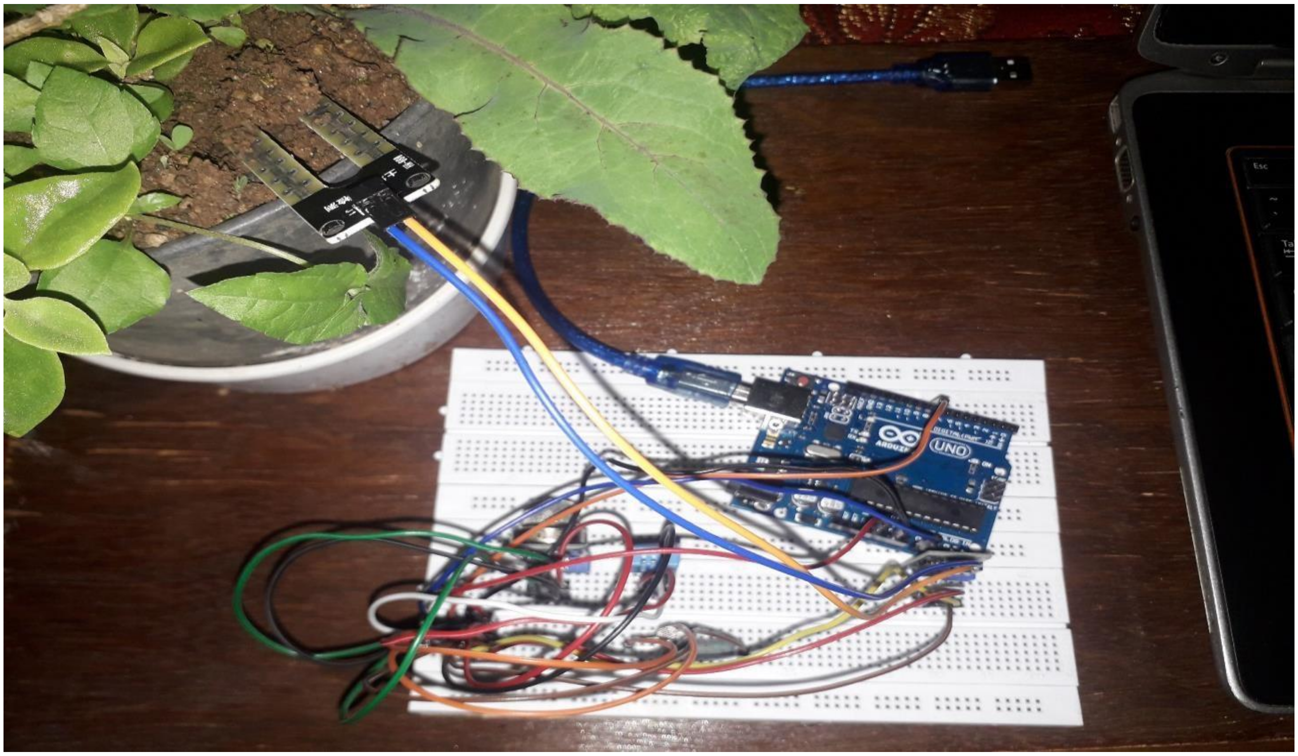

Figure 1: Working Model

5.1.1 Working of Arduino

- Our project is a mixture of hardware and software additives. The hardware part includes embedded systems and software part program is developed using Arduino ide.

- The sensors used are temperature and humidity sensors, soil moisture sensor, light sensor etc. The results gathered with the help of sensors is sent to Arduino UNO.
- The Arduino Uno is an open-source microcontroller board. The board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits.

- The gathered information is displayed in a Arduino IDE. A GSM module is embedded with the Arduino to facilitate messaging service which updates the farmer present climatic conditions of the subject.

5.1.2 Arduino Code

```
#define MQ2pin (0)
#include <dht.h>
#define outPin 8
#define soilWet 500
#define soilDry 750
#define sensorPower 7
#define sensorPin A0

dht DHT;
float gasValue;
int ldrValue=0,moisture,t,h;


void setup()
{
  pinMode(sensorPower, OUTPUT);
  digitalWrite(sensorPower, LOW);
  Serial.begin(9600);
  Serial.println("Gas sensor warming up!");
  delay(10000);
```

```
  Serial.print("Gas");
   Serial.print(",");
   Serial.print("Temperature °C");
   Serial.print(",");
   Serial.print("Humidity % ");
   Serial.print(",");
   Serial.print("Moisture");
   Serial.print(",");
   Serial.print("Light");
   Serial.println("");
}

void loop()
{


  gasValue = analogRead(MQ2pin);

  if(gasValue > 300)
  {
   Serial.print(" | Smoke detected!");
   Serial.println("");
  }

  int readData = DHT.read11(outPin);
  t = DHT.temperature;
  h = DHT.humidity;

int moisture = readSensor();

  ldrValue = analogRead(sensorPin);
  delay(2000);


Serial.print(gasValue);
Serial.print(",");
Serial.print(t);
Serial.print(",");
Serial.print(h);
Serial.print(",");
Serial.print(ldrValue);
Serial.print(",");
Serial.print(moisture);
Serial.println("");
```

```
}

int readSensor() {
  digitalWrite(sensorPower, HIGH);
  delay(10);
  int val = analogRead(sensorPin);
  digitalWrite(sensorPower, LOW);
  return val;

}
```

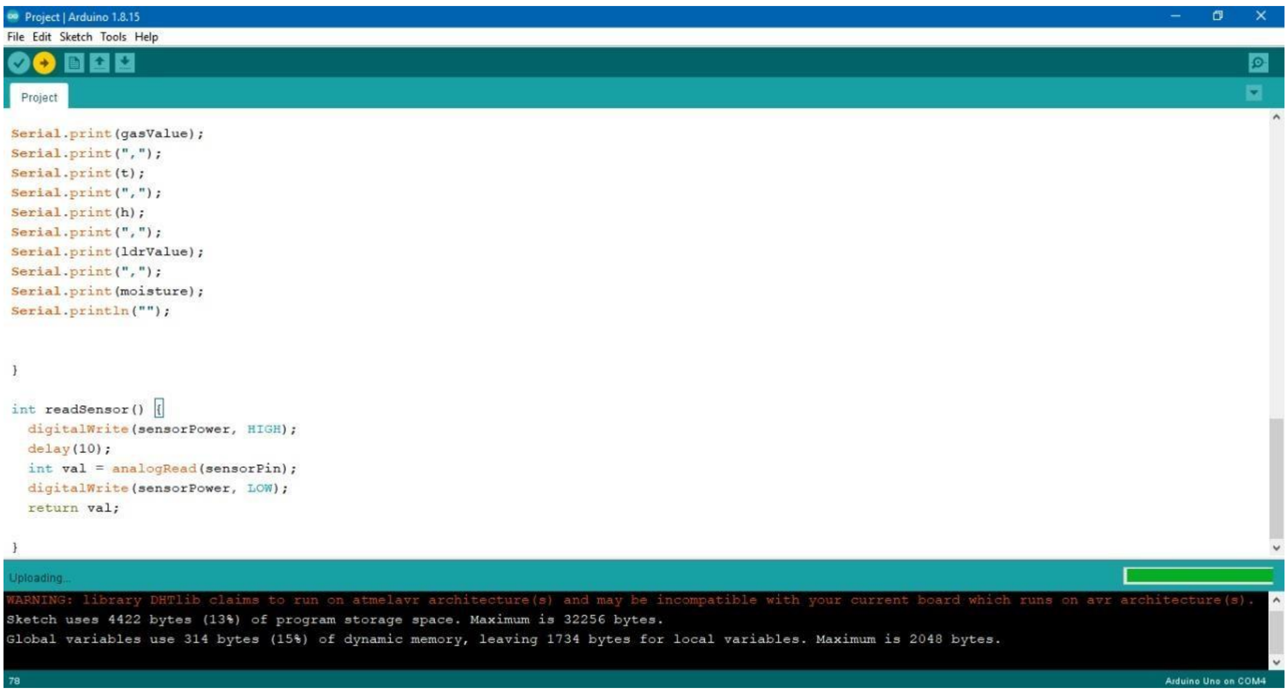

Figure 2: Uploading code to Arduino

5.1.3 Machine Learning (ML):

- Machine Learning technique is used to manage the irrigation effectively and ultimately increase the yield of the crop.

- First, these works consist of data acquisition model for collecting agricultural field data using sensor nodes.

- Next, the data is trained using the ML algorithm for predicting the soil moisture and nutrients for yield maximization.

- Finally, decision is made that which crop is suitable for that environment.

5.1.4 Decision Tree Classifier Algorithm

There are various methods available for analysis of data in machine learning. We have used decision tree classifier.

A decision tree is a flowchart-like tree structure where an internal node represents feature (or attribute), the branch represents a decision rule, and each leaf node represents the outcome.

The working of the decision tree classifier algorithm is explained in the below steps:

Select the best attribute using Attribute Selection Measures(ASM) to split the records.

Make that attribute a decision node and breaks the dataset into smaller subsets. Starts tree building by repeating this process recursively for each child until one of the condition will match:

*All the tuples belong to the same attribute value.

*There are no more remaining attributes.

*There are no more instances

5.1.5 Machine Learning Code

```
# Load libraries
import pandas as pd
from sklearn.tree import DecisionTreeClassifier # Import Decision Tree Classifier
```

```
from sklearn.model_selection import train_test_split # Import train_test_split function
from sklearn import metrics #Import scikit-learn metrics module for accuracy calculation

col_names = ['Gas', 'Temperature', 'Humidity', 'Moisture', 'LDR', 'Result']
# load dataset
pima = pd.read_csv("id3.csv", header=None, names=col_names)
pima.head()

feature_cols = ['Gas', 'Temperature', 'Humidity', 'Moisture', 'LDR', 'Result']
X = pima[feature_cols] # Features
y = pima.Result # Target variable

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=1) # 70%
training and 30% test

# Create Decision Tree classifer object
clf = DecisionTreeClassifier()



# Train Decision Tree Classifer
clf = clf.fit(X_train,y_train)

#Predict the response for test dataset
y_pred = clf.predict(X_test)

# Model Accuracy, how often is the classifier correct?
print("Accuracy:",metrics.accuracy_score(y_test, y_pred))

from sklearn.tree import export_graphviz
from sklearn.externals.six import StringIO
from IPython.display import Image
import pydotplus
```

```
dot_data = StringIO()
export_graphviz(clf, out_file=dot_data,
                filled=True, rounded=True,
                special_characters=True,feature_names = feature_cols,class_names=['0','1'])
graph = pydotplus.graph_from_dot_data(dot_data.getvalue())
graph.write_png('diabetes.png')
Image(graph.create_png())

# Create Decision Tree classifer object
clf = DecisionTreeClassifier(criterion="entropy", max_depth=3)

# Train Decision Tree Classifer
clf = clf.fit(X_train,y_train)

#Predict the response for test dataset
y_pred = clf.predict(X_test)

# Model Accuracy, how often is the classifier correct?
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graph = pydotplus.graph_from_dot_data(dot_data.getvalue())
graph.write_png('diabetes.png')
```
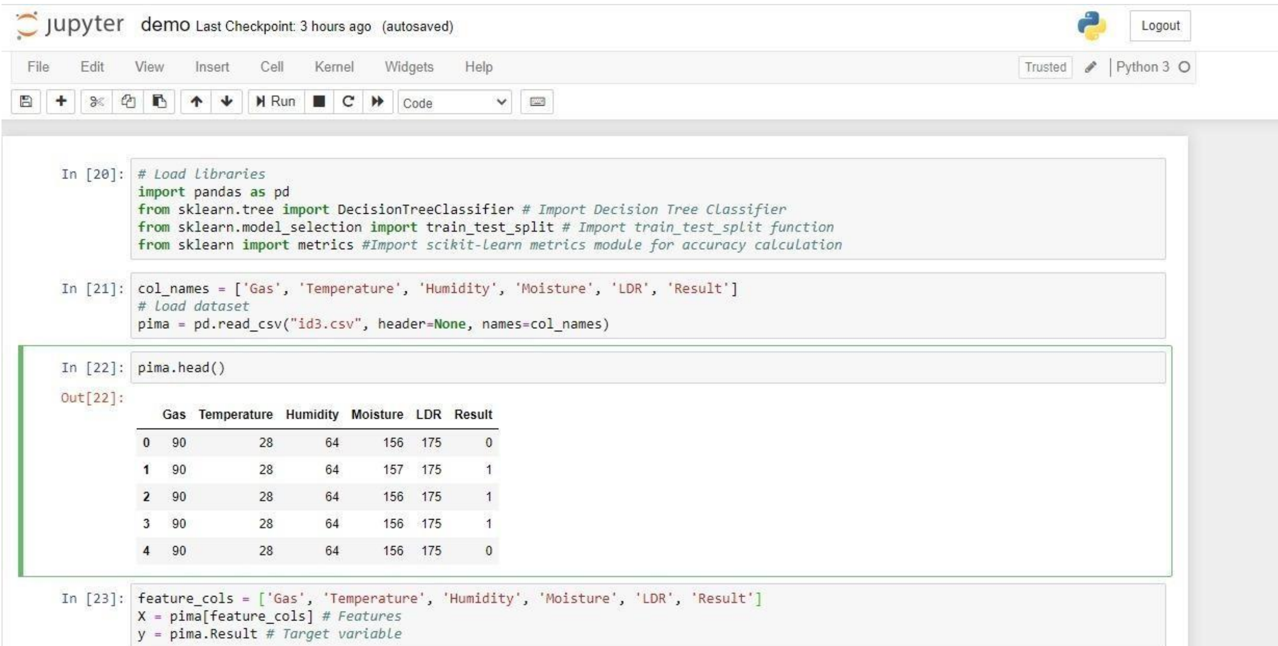

Image(graph.create_png())

print("True is for Average Temperature from 30(degree celcius) to 32(degree celcius ")
print("False is for Average Temperature from 36(degree celcius) to 38(degree celcius ")



In [20]:
```
# Load libraries
import pandas as pd
from sklearn.tree import DecisionTreeClassifier # Import Decision Tree Classifier
from sklearn.model_selection import train_test_split # Import train_test_split function
from sklearn import metrics #Import scikit-learn metrics module for accuracy calculation
```

In [21]:
```
col_names = ['Gas', 'Temperature', 'Humidity', 'Moisture', 'LDR', 'Result']
# load dataset
pima = pd.read_csv("id3.csv", header=None, names=col_names)
```

In [22]:
```
pima.head()
```

Out[22]:

	Gas	Temperature	Humidity	Moisture	LDR	Result
0	90	28	64	156	175	0
1	90	28	64	157	175	1
2	90	28	64	156	175	1
3	90	28	64	156	175	1
4	90	28	64	156	175	0

In [23]:
```
feature_cols = ['Gas', 'Temperature', 'Humidity', 'Moisture', 'LDR', 'Result']
X = pima[feature_cols] # Features
y = pima.Result # Target variable
```

Figure 3: Machine Learning Sample Code

CHAPTER 6

CONCLUSION AND FUTURE WORK

The IOT Based "Automatic Soil Nutrients and Crop Detection Management System using IOT" Our project briefs, that laboratory soil can be shipped to an inexpensive value and value-effective soil control exploitation should be taken as concerned. The project is designed and developed and the device is also coded and checked, taking into account all potential error occurrences. The soil sample is taken by the experimental method since the input is carried out as victimization reagents for the chemical reactions. The color sensors detect related variations in the color sample and address them using quantitative analysis techniques. The soil wetness detector and the temperature detector were used together to analyze the degree and temperature of the wetness of the soil. A GPS was used to obtain the sector condition in order to realize the weather forecast from the nearest meteorological observation. The research has prompted the farmers to have different indications that find the soil reports discrimination mobile IoT - cloud-based mostly soil raft - instead of counting on time intimidating lab soil paper. In addition, in the system, chemicals and sensors are used rather than chemical sensors to make it reasonable for the tip farmers. Collectively the special planning of the kit has increased the property of the system.

6.1 Future Enhancement

In the future, a great number of parameters can be monitored. Application can be made to get visual and audible alert whenever there is any unfavorable condition.The system can be enhanced further to add following functionality: Use of soil moisture sensors, environment sensors, pH sensors to increase the accuracy while predicting the crop. Locations market requirements can be considered, and neighbor farmers crop while suggesting the suitable crop.

CHAPTER 7

RESULTS

7.1 Snapshots

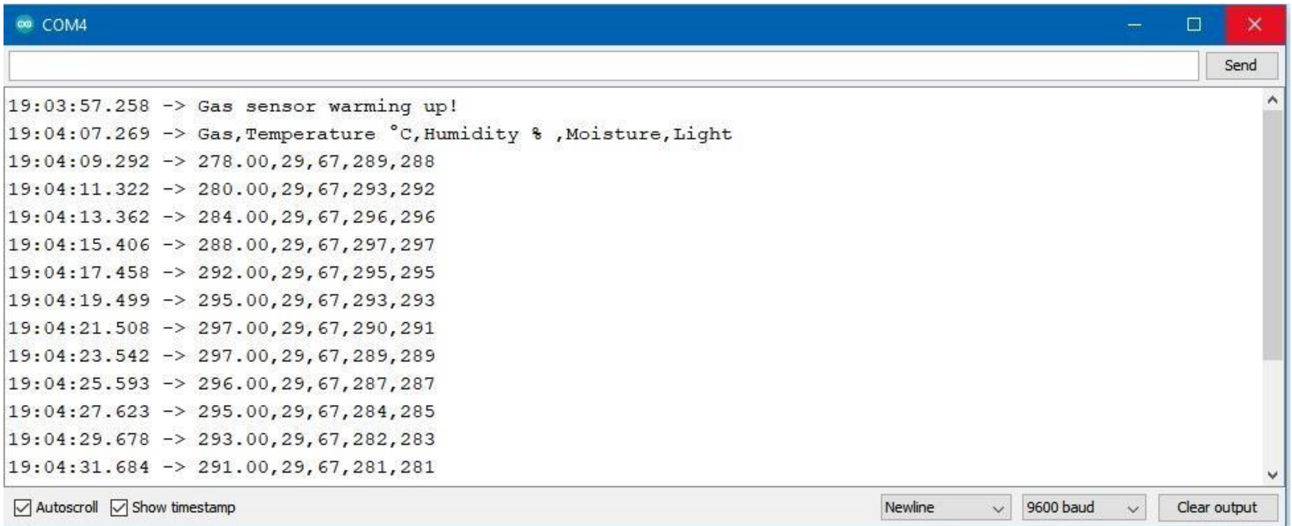


Figure 7.1: Output in the Arduino

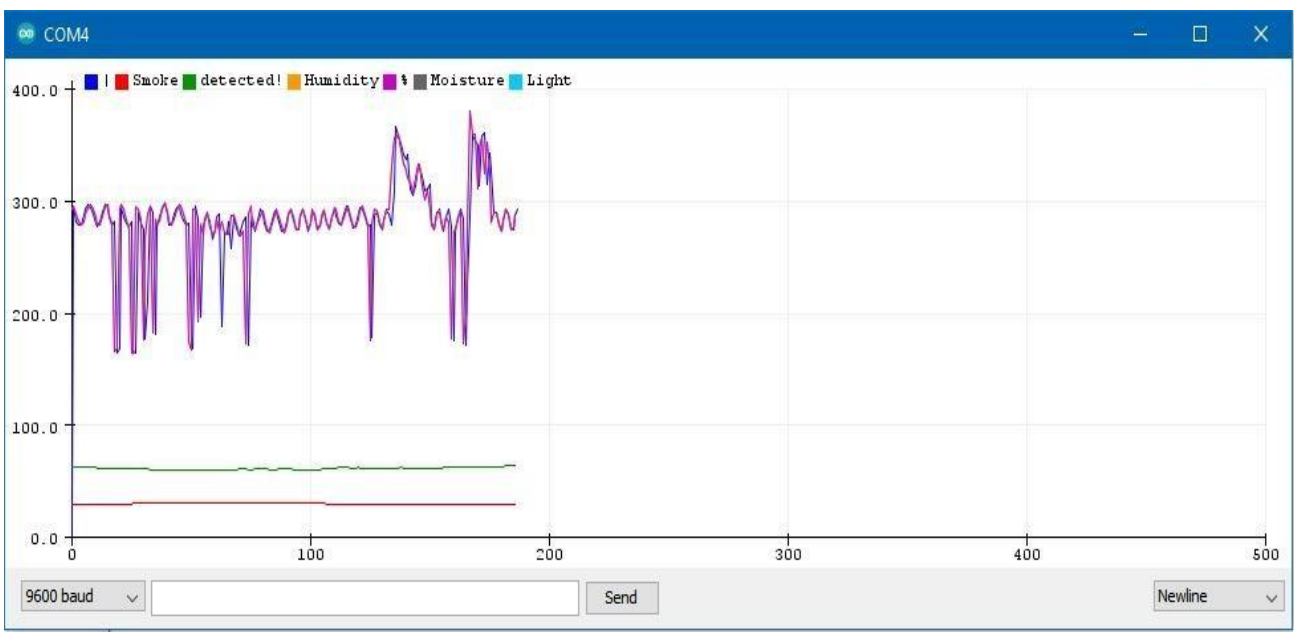


Figure 7.2: Serial Plotter of the readings from sensors.

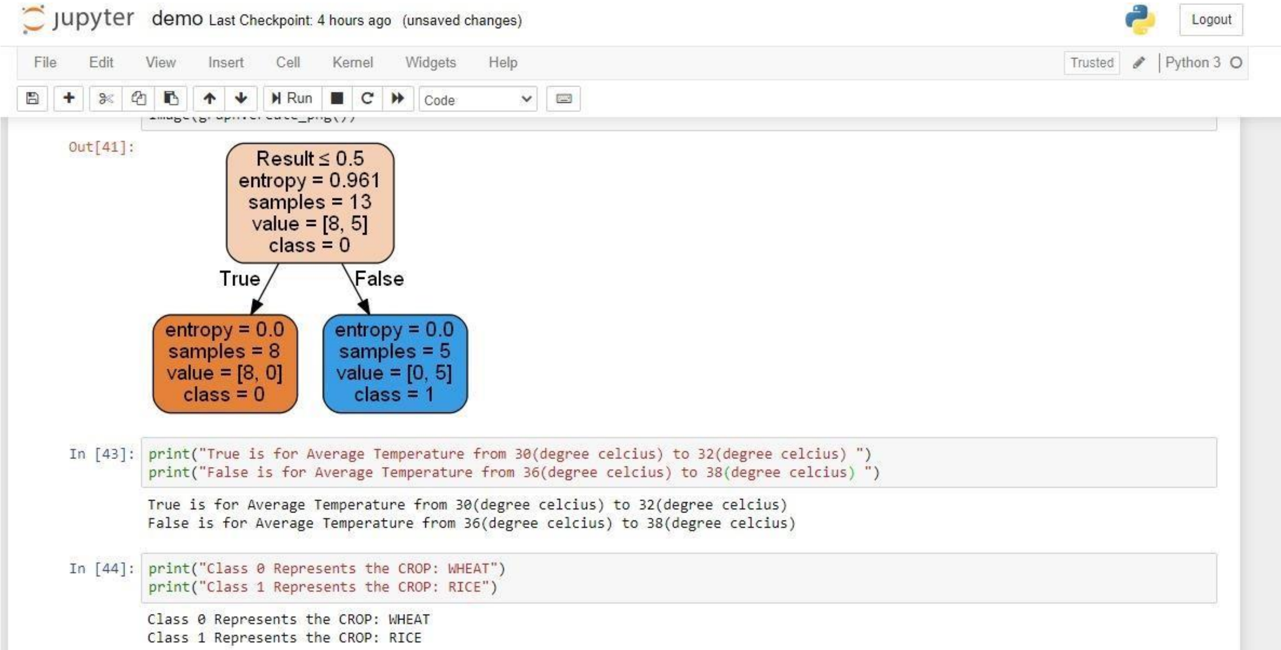


Figure 7.3: Algorithm output for crop prediction

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Vice Principal & HOD
Dept. of CSE, DSATM

Dr. B R Lakshimantha
Principal
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