A Project Report on

Smart Agriculture System

Submitted in partial fulfillment of the requirements for the award of the degree of

Bachelor of Engineering

in

Computer

by

Mugdha Asgekar(16102023)
Shilpa Chandra(16102004)
Samiksha Bhilare(16102025)

Under the Guidance of

Prof.Ramya R.B.

Department of Computer Engineering
A.P. Shah Institute of Technology
G.B.Road,Kasarvadavli, Thane(W), Mumbai-400615
UNIVERSITY OF MUMBAI

Academic Year 2019-2020

Approval Sheet

This Project Report entitled ***"Smart Agriculture System"*** Submitted by ***"Mugdha Asgekar"(16102023), "Shilpa Chandra"(16102004), "Samiksha Bhilare"(16102025)*** is approved for the partial fulfillment of the requirenment for the award of the degree of ***Bachelor of Engineering*** in ***Computer Engineering*** from ***University of Mumbai***.

(Prof.Ramya R.B.)
Guide

Prof. Sachin Malave
Head Department of Computer Engineering

Place:A.P.Shah Institute of Technology, Thane
Date:

CERTIFICATE

This is to certify that the project entitled ***"Smart Agriculture System"*** submitted by **"Mugdha Asgekar"(16102023),"Shilpa Chandra"(16102004),"Samiksha Bhilare"(16102025)** for the partial fulfillment of the requirement for award of a degree ***Bachelor of Engineering*** in ***Computer Engineering***,to the University of Mumbai,is a bonafide work carried out during academic year 2019-2020.

(Prof.Ramya R.B.)
Guide

Prof. Sachin Malave
Head Department of Computer Engineering

Dr. Uttam D.Kolekar
Principal

External Examiner(s)

1.

2.

Place:A.P.Shah Institute of Technology, Thane
Date:

Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, We have adequately cited and referenced the original sources. We also declare that We have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

(Signature)

Mugdha Asgekar(16102023)
Shilpa Chandra(16102004))
Samiksha Bhilare(16102025)

Date:

Abstract

India is an agricultural country and 60-70 percent of our economy is dependent on it. Due to global warming and natural resource scarcity, so the water resources should be used efficiently and precisely for farming. In this proposed system the tedious process is automated. The project proposes a microcontroller based system for automatic smart drip irrigation. Taking in consideration of the weather and soil parameters it will predict the weather and the quantity of water that should flow accordingly through drip irrigation with the help of sensors. By this project the moisture content of the soil in the cultivating field can be controlled. The water flow will be monitored and based on the data available, analysis and prediction will be done. Not only will it help the user to use water wisely in future but also the water supply to crops will be automated based on the conditions which is a win- win situation for both the farmer and the environment also ultimately leading to a good crop yeild.

Contents

List of Figures

List of Tables

List of Abbreviations

ML:	Machine Learning
IOT:	Internet Of Things
KNN:	K nearest neighbour

Chapter 1

Introduction

Traditionally in farming, drip irrigation is not manual which makes it a tedious task for the farmers. In agriculture the major problems which Indian farmers face is the water scarcity and it is getting critical day by day. There are areas in India which also face droughts. To improve the usage of water the drip irrigation system is used. The project proposes a method “Automated Drip irrigation system using weather prediction for efficient use of water resources.” This is proposed as “Smart Drip automated Irrigation system” through IOT and Machine learning and data Analytics

1.1 Problem Definition

In this project the aim is to build a decision support system (DSS) with an overall machine to machine interaction (M2M) and resulting in an intelligent prediction analysis.

1.2 Objectives

1) Not more not less water
2) Will greatly help in saving the water resources.
3) Moisture content of the soil can be controlled.
4) Monitoring of the water flow.
5) Crop requirement is properly analyzed

1.3 Scope

Traditionally in farming, drip irrigation is not manual which makes it a tedious task for the farmers. In agriculture the major problems which Indian farmers face is the water scarcity and it is getting critical day by day. There are areas in India which also face droughts. To improve the usage of water the drip irrigation system is used. This system makes it more effective with a method "Automated Drip irrigation system using weather prediction for efficient use of water resources." The system proposes a "Smart Drip automated Irrigation system" through IOT and Machine learning and data Analytics. The underlying idea behind the project is to help the farmer to use the available water resources more efficiently not only just by sensing the water moisture present in the soil but also by predicting the weather by taking in consideration of the crucial temperature and humidity as parameters. Different crop has different requirements of weather, soil and water requirements. Taking all into consideration through an algorithm we can control and regulate the amount of flow of water. This will benefit the environment and also the farmers.

Chapter 2

Literature Review

IEEE Paper 1
Smart Drip Irrigation System for sustainable Agriculture By Kavianand DOI: 10.1109/TIAR.2016.7801206

Mahir Dursun and Semih Ozden," A wireless application of drip irrigation automation supported by soil moisture sensors", Scientific Research and Essays Vol. 6(7), pp. 1573-1582, 4 April, 2011

Gayatri Londhe et al, "Automated Irrigation System By Using ARM Processor", IJSRET Volume 3, Issue 2, May 2014

Intelligent IoT Based Automated Irrigation System Yuthika Shekhar, Ekta Dagur, Sourabh Mishra

Proposed System by the author(s):
The system is used to turn the valves ON or OFF automatically as per the water requirement of the plants. The system is used for sensing, monitoring, controlling and for communication purpose. Different sensors are used to detect the different parameters of the soil like moisture, temperature, humidity, pH of soil and nitrogen content of the soil. Depending upon the sensors output the ARM9 processor will take the necessary action. The moisture sensor output will help to determine whether to irrigate the land or not depending upon the moisture content.

Proposed System of this Project : This system will predict the nature of the soil and then accordingly predict the water content that must be given to the specific crop. Humdity,temperature,moisture parameters are considered which are trained to predict the target value (which is the nature of the soil).

When live data is taken through the sensors, through KNN classification , target value is predicted further using Blaney-Criddle Equation.

Chapter 3

Technology Stack

Programming languages Used:

1)Machine Learning : Python and it's libraries
2)Arduino Nano : Arduino IDE
3)GUI : Flask(micro web framework written in Python)

How it will be used ?

The DHT11 and Soil Sensor will be connected with the Arduino Nano. Then the real time data is taken and is sent as an input in our system. Now machine learning algorithm will be applied through python as it takes these real time input and predict the soil nature. Then the Blaney-Criddle Equation is used to calculate the amount of water to be used in drip irrigation.

Chapter 4

Benefits and Applications

4.1 Benefits For Environment

Effective use of water is the mantra of this project.When the water is used in appropriate quantities the soil properties is used to it's maximum extent. Suppose for example,peanuts require less water whereas cotton requires then the water content should be provided respectively.

4.2 Benefits For Society

Agriculture sector in India contributes to a major source of income . Irrigation is an essential component of crop production in many areas. Right now in India drip irrigation systems are operated manually. Effective use of water is the main concern of this project.Traditionally people used to go to farms inorder to adjust the water requirements . The solution to this problem will be solved using automated drip irrigation system. Using automated drip irrigation system the water requirements will automatically be detected depending upon on the moisture content of soil,temperature,humidity and climate and also depending upon on the water requirements for the particular crops.

4.3 Applications

1) Will help farmers to not operate drip irrigation system manually.

2)It will only output the amount the water required by the particular crop accordingly.

3)We will also show the farmer the cureent status of the farm via web application .

Chapter 5

Project Design

5.1 Proposed System

Agriculture is wide occupation in our densely populated country. As lot of water is needed in agriculture a lot gets wasted also. In this project it is proposed to minimise the water use by giving only the precise amount of water required by the crops. This will be done by taking the data from soil and crop into consideration, applying machine learning algorithm in it and using Blaney-Criddle equation for measuring the evapotranspiration of the crop. This will help the crops to grow better as no excess water is given.

5.2 Flow Of Modules

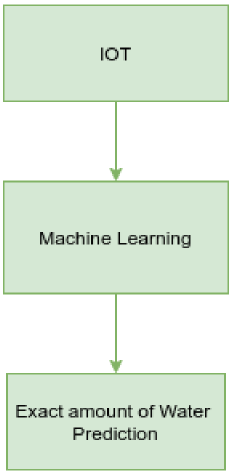


Figure 5.1: Flow Of Modules

5.3 Activity Diagram

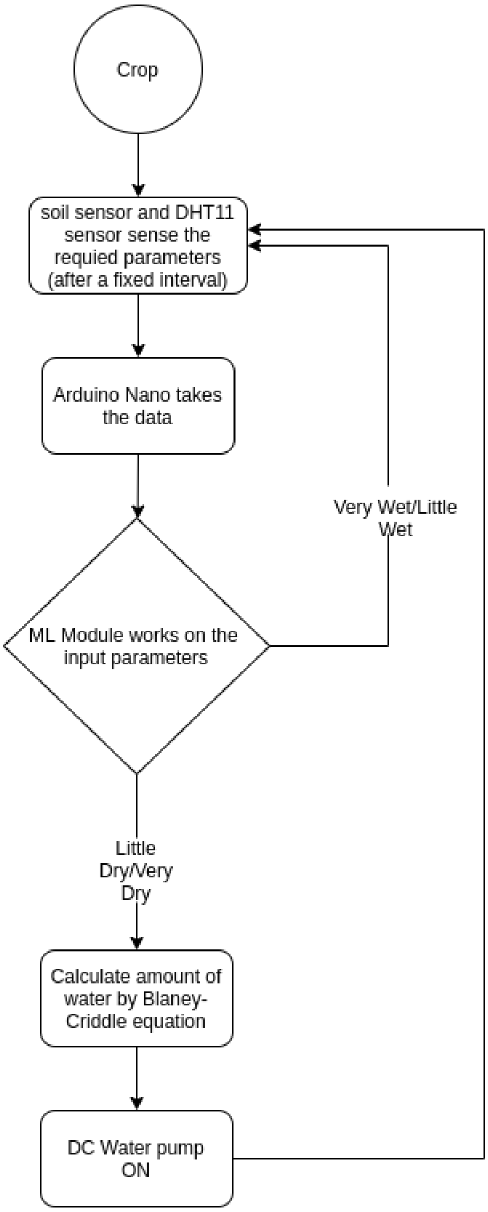


Figure 5.2: Activity Diagram

5.4 Use Case

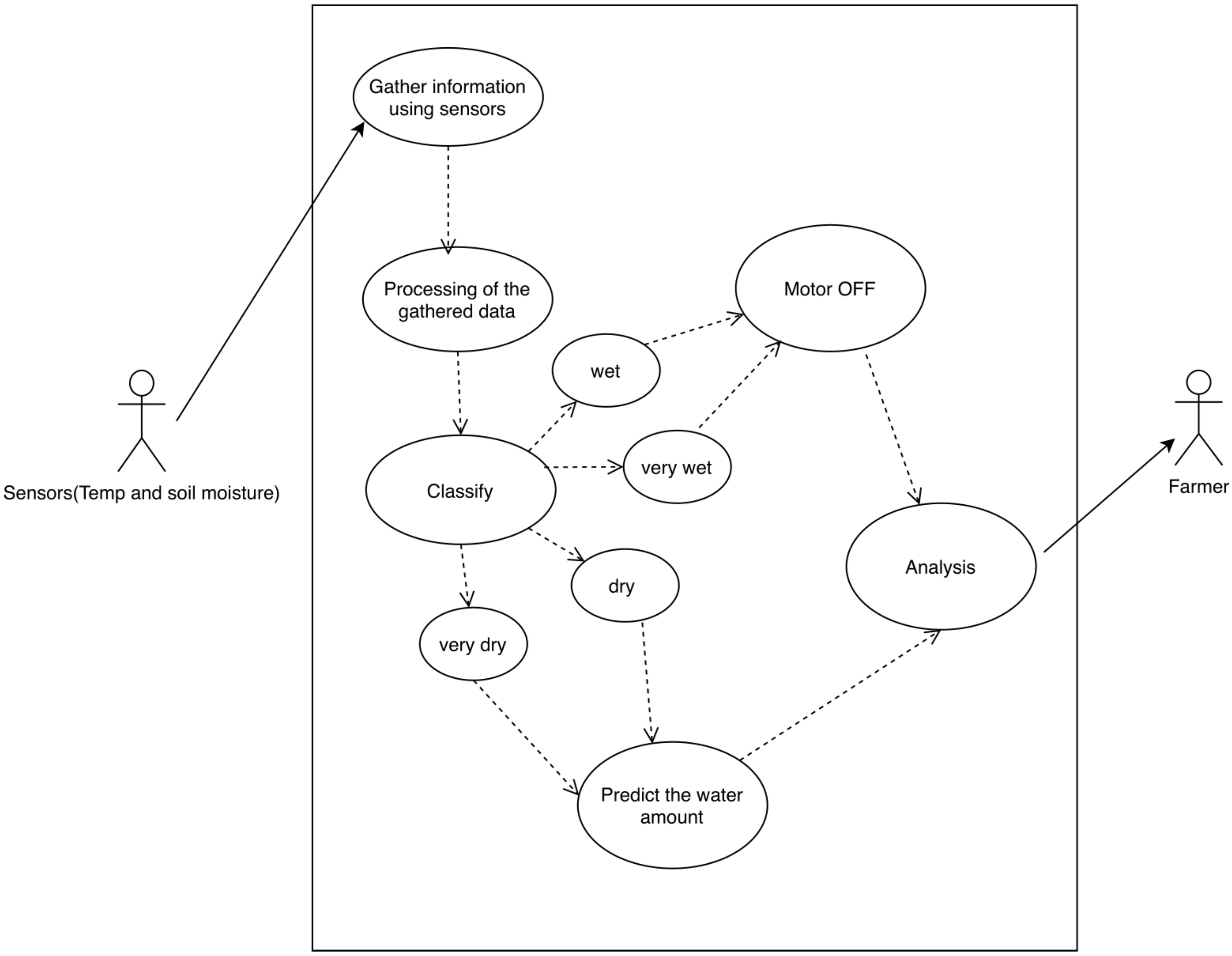


Figure 5.3: Use Case

5.5 Description Of Use Case Diagram

The sensors will collect the data such as temperature, soil moisture and humidity. After gathering information we will apply machine learning algorithm to the data and predict the amount of water that will go in the crop using Blaney-Criddle Equation. Using the dataset and the pattern of parameters and the output predicted analysis is done as to when the soil moisture is the most.

Chapter 6

Modules of System

The project is divided into various modules to help the work divide into small yet efficient modules. Each modules output acts as an input to the next module. Each module requires a specific set of knowledge and skill which takes time hence they have been divided accordingly.

6.1 Prediction of soil nature and water

In this module collection of data such as soil moisture and temperature will be done and categories the tuples as little dry/very dry/little wet/very wet. KNN algorithm will be used in making the classification happen.When KNN is used for classification, the output can be calculated as the class withthe highest frequency from the K-most similar instances. Each instance in essence votes for their class and the class with the most votes is taken as the prediction. KNN works well with a small number of input variables (p), but struggles when the number of inputs is very large.As the dataset contains less than 2000 tuples KNN will be perfectly suitable for the dataset. After the classes are specifies if it is very dry/little dry then only it will take those tuples and calculate the water required by using the evapotranspiration formula.

6.2 Assembling of components

In this module we require soil moisture and temperature sensors attached to the Arduino nano. The machine learning module will be present on the local machine. The sensors will sense the live data and the machine learning algorithm will be applied on it.The DC Water pump will be connected to the Arduino nano which will give the water output as specified by the evapotranspiration algorithm.

6.3 Machine Learning and Evapotranspiration Algorithm

KNN is a supervised machine learning (ML) algorithm. KNN is used for classification of type of soil. After the soil is classified the system has to estimate the water requirement of the crop. The water requirement of the crop is same as that of evapotranspiration rate so that it becomes ideal for the crop to grow. The water requirement will only be calculated if the soil is either dry or very dry. In this proposed system we will be using the method Blaney-Criddle Equation to determine the water required by the crop.

6.4 Analysis of data

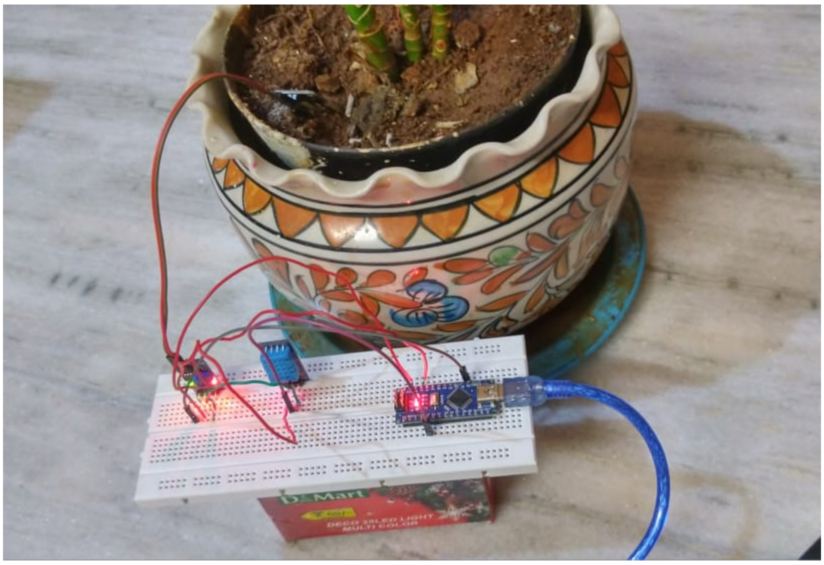
After the entire is gathered entirely the detailed review will be given as to how the parameters humidity, temperature and soil moisture depend on each other.

Chapter 7

Project Implementation

7.1 Sensors

The first step of the implementation process is assembling the sensors and interfacing them with the arduino board as seen in the figure below. The sensors used are the temperature and humidity sensor and the soil moisture sensor.Temperature and soil moisture play an important role in deciding the amount of water to be flown into the soil.The values of temperature and soil moisture is obtained on the arduino IDE.The accuracy of these sensors need to be verified for better accuracy of the output.



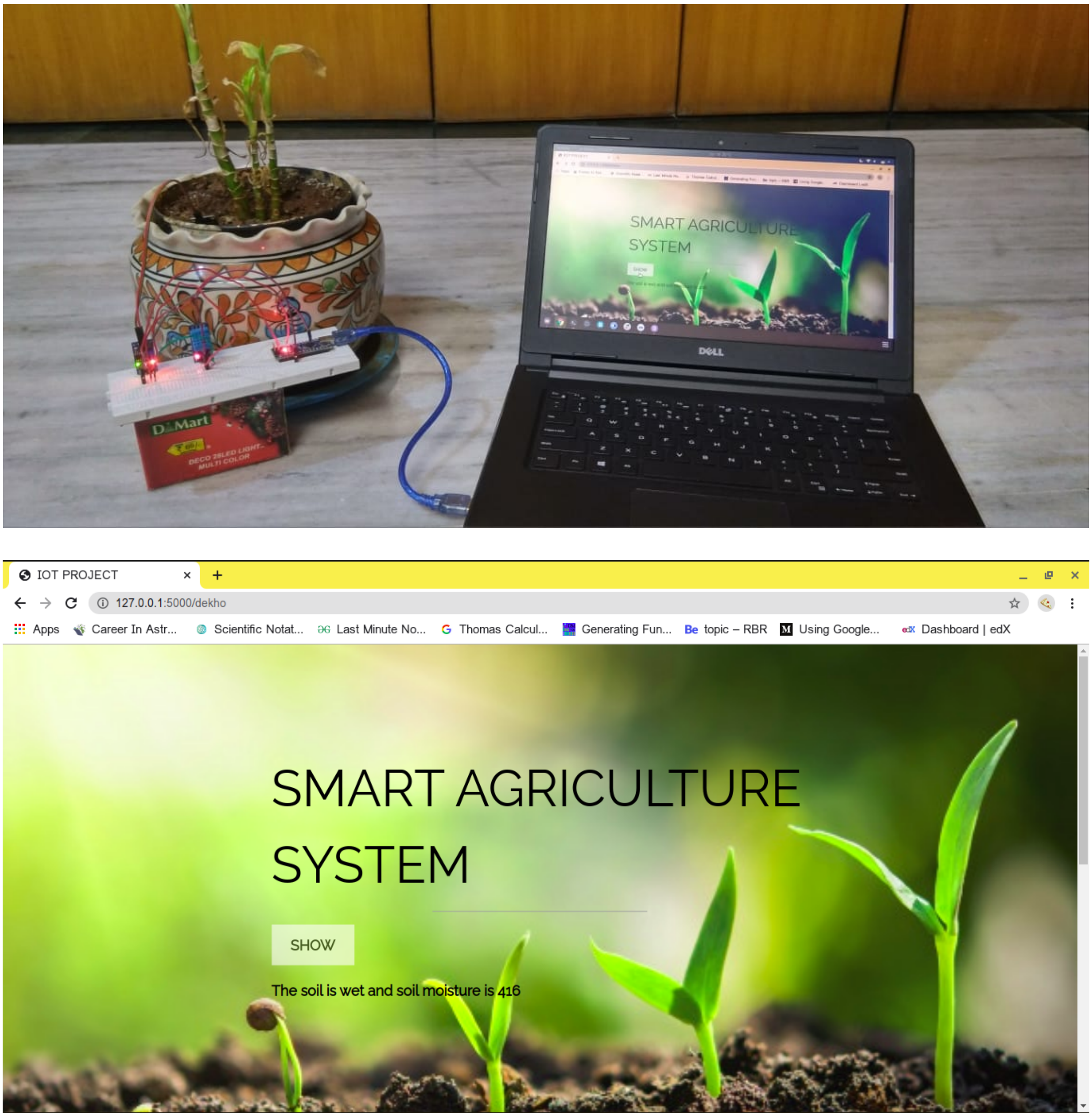
DHT11 sensor and soil sensor are interfaced with the ArduinoNano

7.2 Dataset

The second step after setting up the sensors, is the preparation of the dataset. The dataset has been prepared by collecting samples of each soil. The temperature and the soil moisture has been calculated or collected with the help of sensors. The dataset prepared is stored into .csv file and provided as an input to the machine learning algorithm. Based on the dataset provided the machine learning algorithm will provide output for other values of temperature and moisture. In the dataset for each temperature and moisture value the amount of water is calculated by using the concept and formula of evapotranspiration.

7.3 Machine learning

After collecting the values and preparing the dataset, .csv file is provided to the machine learning algorithm. The KNN algorithm of machine learning is used in the prediction process. The K Nearest Neighbour algorithm is a classification algorithm which groups the values into classes by calculating the euclidean distance with each other. The classes formed in this are wet,very wet,dry and very dry. The algorithm puts the new input value in any one of the classes by calculating euclidean distance with those classes. The value is entered into that class with which its distance is minimum amongst all. As seen below the soil is wet so it shows wet soil in the UI which has been predicted correctly.



The UI displays wet soil and the moisture content

7.4 Blaney-Criddle Equation

After figuring out the type of soil, the system has to estimate the water requirement of the crop. The water requirement of the crop is same as that of evapotranspiration rate so that it becomes ideal for the crop to grow. The water requirement will only be calculated if the soil is either dry or very dry. In this proposed system Blaney-Criddle Equation will be used to determine the water required by the crop. The Blaney-Criddle formula:

ET0 = p (0.46 Tmean +8) where:
ET0 = Reference crop evapotranspiration (mm/day)
as an average for a period of 1 month
Tmean = mean daily temperature (°C)
p = mean daily percentage of annual daytime hours

After this, the actual amount to be given to the crops is determined by:
ETcrop = ET0 * Kc
as water may vary for each crop.
In this system we have considered the crop as tomato. The Kc coefficient incorporates crop characteristics and averaged effects of evaporation from the soil [5]. Kc for tomato is 0.45,0.75,1.15,0.80 for intial stage, crop development stage, mid-season stage, late season stage respectively. The final value Etcrop calculated is the actual value of the water which will be given by the dc water pump.

Chapter 8

Testing

8.1 Evaluation procedure - Train/Test split

1. Splitting the dataset into two sets: a training set and a testing set.
2. Train the model on the training set.
3. Test the model on the testing set, and evaluate how well our model did.

Test size = 0.25
1. 25 % of observations to test set
2. 75 % of observations to training set

Data is randomly assigned unless you use random state hyperparameter
1. If you use random state= 0
2. Our data is split exactly the same way

8.2 Accuracy Score

Compare actual response values (y_text) with predicted response values (y_pred)

Code:

```
In [13]: # for accuracy calculation
         from sklearn import metrics

         print("Accuracy:",metrics.accuracy_score(y_test, y_pred))

         Accuracy: 0.9027777777777778
```

The model gives an accuracy score of 90.27 %

Code:

```
from sklearn.neighbors import KNeighborsClassifier
classifier = KNeighborsClassifier(n_neighbors = 7 , metric = 'minkowski', p = 2)
classifier.fit(X_train, y_train)
```

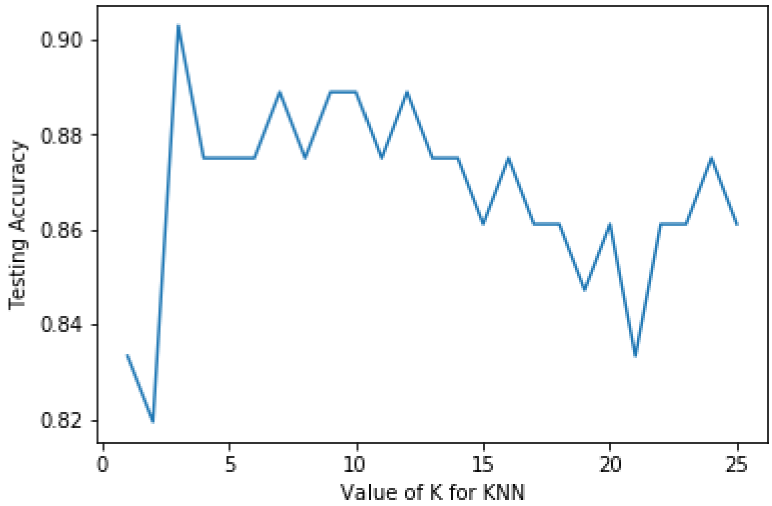
Say we use, K neighbours = 7
The value of K can be found by algorithm tuning. We tried using many values of K and K = 3 worked best for our problem.
Algorithm Tuning:

```
In [11]: import matplotlib.pyplot as plt

         # allow plots to appear within the notebook
         %matplotlib inline

         # plot the relationship between K and testing accuracy
         # plt.plot(x_axis, y_axis)
         plt.plot(k_range, scores)
         plt.xlabel('Value of K for KNN')
         plt.ylabel('Testing Accuracy')

Out[11]: Text(0, 0.5, 'Testing Accuracy')
```



The above graph plots the relationship between K and testing accuracy. The graph clearly indicates that the testing accuracy is highest for K = 3

```
In [15]: dataList = [10,40,90]
         predicted= classifier.predict([dataList])
         print(predicted)

['very wet']
```

Adding soil moisture, temperature and humidity values in the dataList and gives us the output very wet soil which is correct.

```
In [16]: dataList = [990,20,65]
         predicted= classifier.predict([dataList])
         print(predicted)

['very dry']
```

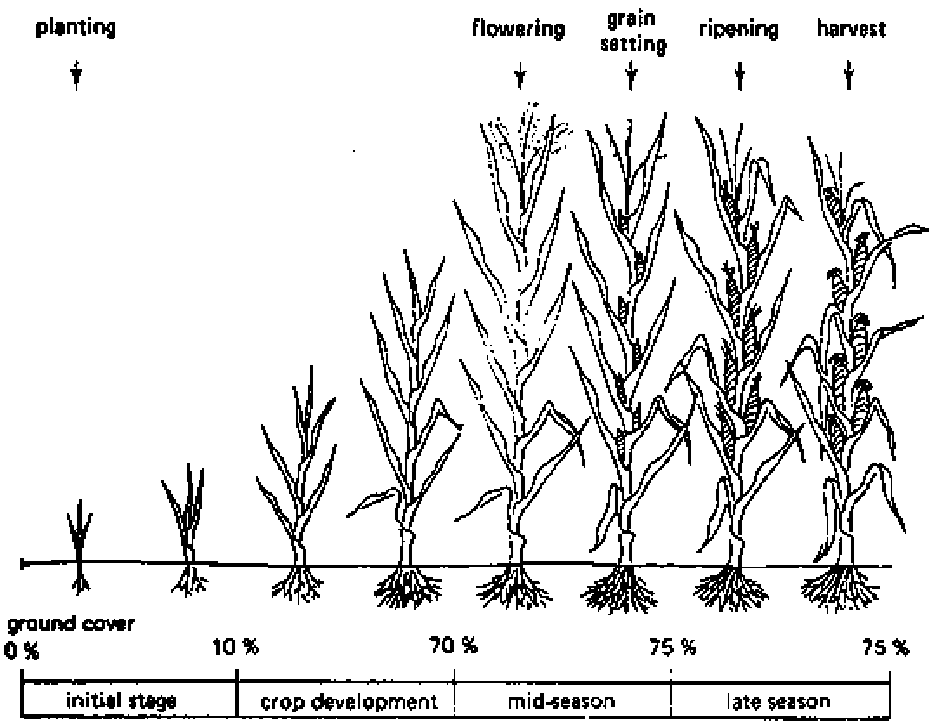
The model gives correct output which is very Dry soil.

Chapter 9

Result and Analysis

9.1 Analysis of results

• Once the Arduino gets the data from the sensors it sends the real time value to the ML module located on the local machine via serial communication as input parameters.The ML module on determing the type of the soil as any one of the following : very dry,little dry,little wet,very wet , give the of final predicted output.
• If the soil is very dry or little dry then only switches on the DC water pump. And gives the exact amount of water calculated by the evapotranspiration method.
• After supplying the water the required parameters are again checked after a fixed interval of time.
• If the soil is very wet or little wet then no water is required as soil has enough moisture. So it again check the soil after a fixed interval of time.
• Initial stage, crop development stage, mid-season stage and late season stage of tomato is 30-35,40-45,40-70,25-30 respectively.
• The total amount of time required for the growth of tomato crop right from sowing is 135-180 days depending upon the type of region(humid,semi humid,arid,semi arid).
• The crop development stages can be seen in the figure below which shows that maximum time is taken in the mid-season.



Crop Development Stages

9.2 Graphical Representation

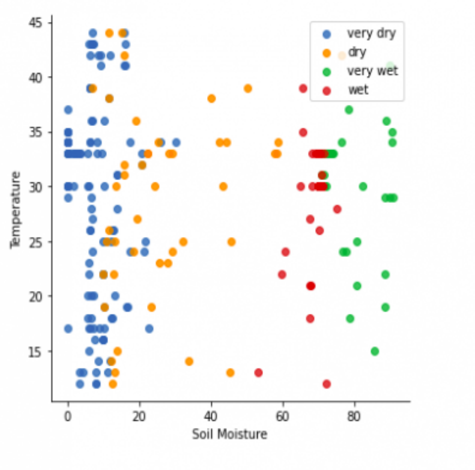


Figure 9.1: Soil Mositure v/s Temperataure

It is observed that as the soil moisture increases the soil becomes more and more wet as shown in the Figure 9.1.

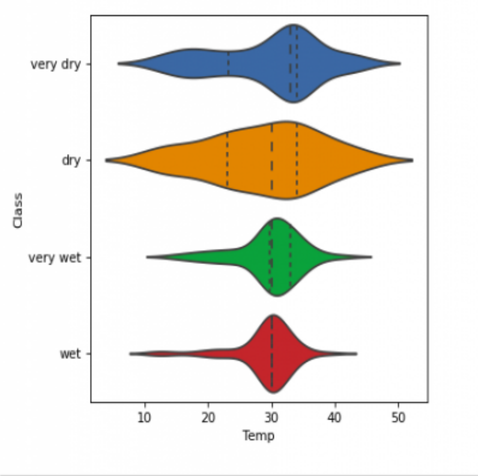


Figure 9.2: Temperature v/s Class

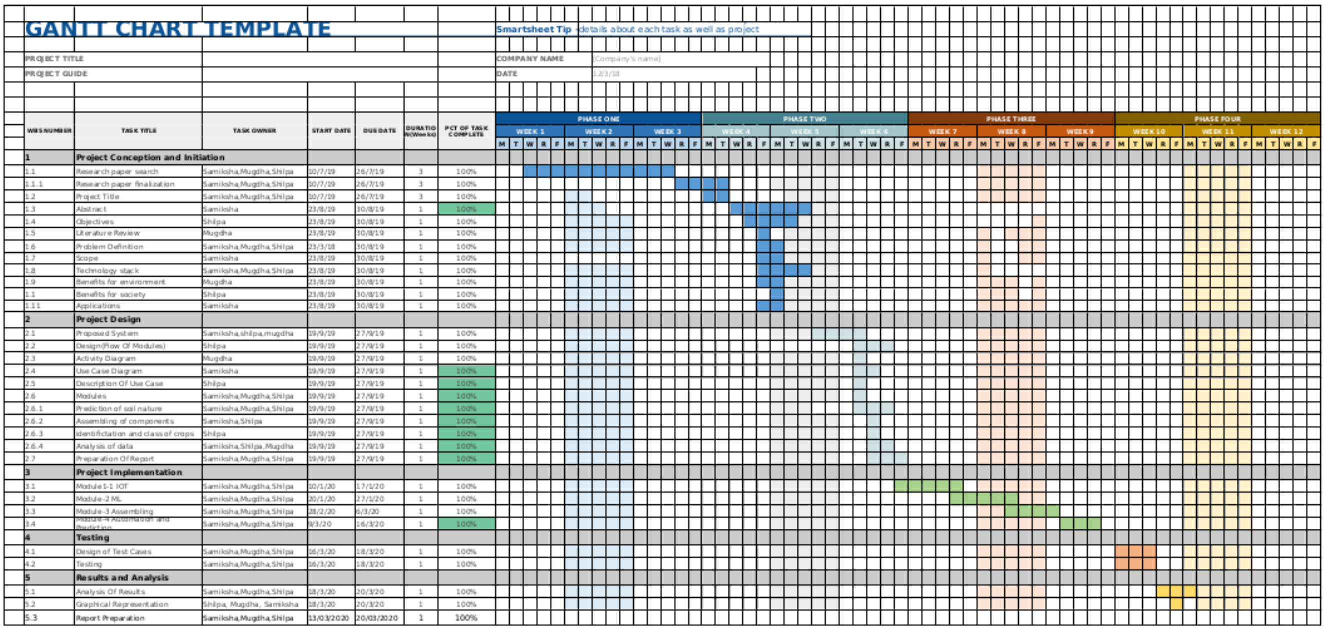
It is observed that very wet soil mostly lies between a temperature range of 25-40°C whereas very dry peaks during 28-42°C and also 15-25°C as shown in Fig 9.2.

So very wet and very dry soil can clash between the same temperature ranges. And that is why it becomes very important to consider more parameters like humidity, soil moisture also take into consideration for more accurate results.

Chapter 10

Annexure A

10.1 Gantt Chart



WBS NUMBER	TASK TITLE	TASK OWNER	START DATE	DUE DATE	DURATION(Weeks)	PCT OF TASK COMPLETE
1	**Project Conception and Initiation**					
1.1	Research paper search	Samiksha,Mugdha,Shilpa	10/7/19	26/7/19	3	100%
1.1.1	Research paper finalization	Samiksha,Mugdha,Shilpa	10/7/19	26/7/19	3	100%
1.2	Project Title	Samiksha,Mugdha,Shilpa	10/7/19	26/7/19	3	100%
1.3	Abstract	Samiksha	23/8/19	30/8/19	1	100%
1.4	Objectives	Shilpa	23/8/19	30/8/19	1	100%
1.5	Literature Review	Mugdha	23/8/19	30/8/19	1	100%
1.6	Problem Definition	Samiksha,Mugdha,Shilpa	23/3/18	30/8/19	1	100%
1.7	Scope	Samiksha	23/8/19	30/8/19	1	100%
1.8	Technology stack	Samiksha,Mugdha,Shilpa	23/8/19	30/8/19	1	100%
1.9	Benefits for environment	Mugdha	23/8/19	30/8/19	1	100%
1.1	Benefits for society	Shilpa	23/8/19	30/8/19	1	100%
1.11	Applications	Samiksha	23/8/19	30/8/19	1	100%
2	**Project Design**					
2.1	Proposed System	Samiksha,shilpa,mugdha	19/9/19	27/9/19	1	100%
2.2	Design(Flow Of Modules)	Shilpa	19/9/19	27/9/19	1	100%
2.3	Activity Diagram	Mugdha	19/9/19	27/9/19	1	100%
2.4	Use Case Diagram	Samiksha	19/9/19	27/9/19	1	100%
2.5	Description Of Use Case	Shilpa	19/9/19	27/9/19	1	100%
2.6	Modules	Samiksha,Mugdha,Shilpa	19/9/19	27/9/19	1	100%
2.6.1	Prediction of soil nature	Samiksha,Mugdha,Shilpa	19/9/19	27/9/19	1	100%
2.6.2	Assembling of components	Samiksha,Shilpa	19/9/19	27/9/19	1	100%
2.6.3	identifictation and class of crops	Shilpa	19/9/19	27/9/19	1	100%
2.6.4	Analysis of data	Samiksha,Shilpa,Mugdha	19/9/19	27/9/19	1	100%
2.7	Preparation Of Report	Samiksha,Mugdha,Shilpa	19/9/19	27/9/19	1	100%
3	**Project Implementation**					
3.1	Module 1-1 IOT	Samiksha,Mugdha,Shilpa	10/1/20	17/1/20	1	100%
3.2	Module-2 ML	Samiksha,Mugdha,Shilpa	20/1/20	27/1/20	1	100%
3.3	Module-3 Assembling	Samiksha,Mugdha,Shilpa	28/2/20	6/3/20	1	100%
3.4	Module-4 Automation and Prediction	Samiksha,Mugdha,Shilpa	9/3/20	16/3/20	1	100%
4	**Testing**					
4.1	Design of Test Cases	Samiksha,Mugdha,Shilpa	16/3/20	18/3/20	1	100%
4.2	Testing	Samiksha,Mugdha,Shilpa	16/3/20	18/3/20	1	100%
5	**Results and Analysis**					
5.1	Analysis Of Results	Samiksha,Mugdha,Shilpa	18/3/20	20/3/20	1	100%
5.2	Graphical Representation	Shilpa, Mugdha, Samiksha	18/3/20	20/3/20	1	100%
5.3	Report Preparation	Samiksha,Mugdha,Shilpa	13/03/2020	20/03/2020	1	100%

Chapter 11

Future Scope

In the future Image Processing can be done on the crop which are grown using Drip Irrigation. The crop assessment can be done to classify the crops if it healthy/unhealthy/under-grown or not using CNN. And the report can be sent to the farmer with the analysis involved that how much crop yield will happen depending on the crop heath growth.

Bibliography

[1] Smart Drip Irrigation System for sustainable Agriculture By Kavianand DOI: 10.1109/TIAR.2016.7801206

[2] Mahir Dursun and Semih Ozden," A wireless application of drip irrigation automation supported by soil moisture sensors", Scientific Research and Essays Vol. 6(7), pp. 1573-1582, 4 April, 2011.

[3] Gayatri Londhe et al, "Automated Irrigation System By Using ARM Processor", IJSRET Volume 3, Issue 2, May 2014

[4] Intelligent IoT Based Automated Irrigation System Yuthika Shekhar, Ekta Dagur, Sourabh Mishra

Appendices

Appendix-A: Arduino IDE Installation

1. Download the latest version of the Arduino IDE from the Arduino website (https://www.arduino.cc/en/Main/Software) as a tarball. A tarball is a type of compressed folder, like a .zip file, commonly used to distrubute software in Linux

2. In order to extract the files we need from the tarball, we can open a terminal, cd to where the downloaded tarball is, then run
tar xvf FILENAME
where FILENAME is the name of the download (typically arduino-(version number)-linux64.tar.xz). When the command finishes, run ls again; tar should have created a new folder named arduino-(version number).

3. cd into the folder; there will be a file named install.sh in the folder. To install the IDE, execute install.sh with
./install.sh

4. Before launching the IDE, connect the Arduino board to the computer with a USB cable.

5. Give the ubuntu port /dev/ttyUSB0 permission by command
sudo chmod a+rw /dev/ttyUSB0
on the terminal.

Thus arduino IDE is set-up and installed.

Appendix-B: Jupyter Notebook Installation

1. First update the local apt package index and then download and install the packages:
sudo apt update
Next, install pip and the Python header files, which are used by some of Jupyter's dependencies: **sudo apt install python3-pip python3-dev**

2. Now that we have Python 3, its header files, and pip ready to go, we can create a Python virtual environment to manage our projects. We will install Jupyter into this virtual environment.
To do this, we first need access to the virtualenv command which we can install with pip.
sudo -H pip3 install virtualenv
The -H flag ensures that the security policy sets the home environment variable to the home directory of the target user.

3. With virtualenv installed, we can start forming our environment.Create and move into a directory where we can keep our project files.
mkdir /my-project-dir cd /my-project-dir

4. Within the project directory, we'll create a Python virtual environment.
virtualenv my-project-env
This will create a directory within your project directory. Inside, it will install a local version of Python and a local version of pip.

5. **source my-project-env/bin/activate**
Before we install Jupyter, we need to activate the virtual environment.

6. Install jupyter
pip install jupyter

7. Run it by:
jupyter notebook

Appendix-C: Flask Installation

1. Installing Python 3 and venv:
python3 -V

2. To install the python3-venv package that provides the venv module run the following command:
python3 -m venv venv
The command above creates a directory called venv, which contains a copy of the Python binary, the Pip package manager, the standard Python library and other supporting files.

3. To start using this virtual environment, you need to activate it by running the activate script: **source venv/bin/activate**

4. Installing Flask :
pip install Flask

5. For running Flask, run the main application file using:
python3 app.py

6. The output will show :
Running on http://127.0.0.1:5000
5000 is the default port number of flask.
Open this link onto the browser and thus the web application is accessed.

Acknowledgement

We have great pleasure in presenting the report on **Smart Agriculture System** We take this opportunity to express our sincere thanks towards our guide **Ramya R.B.** Department of Computer Engineering, APSIT thane for providing the technical guidelines and suggestions regarding line of work. We would like to express our gratitude towards her constant encouragement, support and guidance through the development of project.

We thank **Prof. Sachin Malave** Head of Department,Computer Engineering, APSIT for his encouragement during progress meeting and providing guidelines to write this report.

We thank **Prof. Amol Kalugade** BE project co-ordinator, Department of Computer Engineering, APSIT for being encouraging throughout the course and for guidance.

We also thank the entire staff of APSIT for their invaluable help rendered during the course of this work. We wish to express our deep gratitude towards all our colleagues of APSIT for their encouragement.

Mugdha Asgekar:
16102023:
Shilpa Chandra:
16102004:
Samiksha Bhilare:
16102025: