Smart Crop Monitoring and Plant Disease Detection

by Satya Praneeth

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CHAPTER-1

INTRODUCTION

As per the declaration by the U.S. Global change research program, due to the variation in the climate change there has to be plenty of challenges arising about the crop productivity and the rural economy. Smart Farming is an efficient way of growing crops in a sustainable way. Smart Farming eliminates the need of physical work done in farms and also helps in the Improvement of Productivity. But our farmers depend on the traditional strategies such as cultivation of seeds and furrowing but our monsoons are unpredictable and the water efficiency is a major problem. Conventional methods like watering plants, fertilizing fields and spraying pesticides without proper methods of cultivation can lead to inadequate crop growth.

IOT has brought many latest agricultural benefits like efficient water management and many more. The Proposed Model consists of Sensors like Soil Moisture Sensor, Humidity & Temperature Sensors, and a Motor representing a water pump. The Internet of Things is a system consisting of actuators or sensors or both provides connectivity to the internet directly or indirectly. In this project we are going to deal with various sensors like and the detection of leaf disease which will help to Which will help to give us the better productivity of the crop with use of Temperature, Humidity, Soil Moisture, Image Sensors etc. Smart Crop Monitoring helps farmers stay connected to the farms and thus helps in easy monitoring and controlling of the Farm Field Activities.

CHAPTER-2

PROBLEM STATEMENT

The Motivation to take up this project are farmers who work solely in the farmlands and are still dependent on traditional methods. So to provide an efficient decision support system using wireless sensor networks which handle different activities of the farm and gives useful information related to the farm field to farmers. Agriculture is the backbone of the economy of Indian government. There is a requirement of a lot of production of crops to fulfil the needs of Indian population. Because of diseases, a large amount of crop production has decreased. There are various types of diseases on the plant leaf that cause problems in the development of crops. Human eyes are not so much stronger to see the leaf diseases so humans do not observe variation in the infected part of the leaf. These diseases sometimes may not be visible to human eyes and they directly affect the crop. We will also be working on Plant Disease detection using machine learning for farm field activities in order to provide information to farmers about diseases that are occurring So that they can spray the pesticides accordingly. This will help the farmer produce good yield. We will be working on okra and coriander in specific.

CHAPTER-3

LITERATURE SURVEY

In this chapter, we present the current knowledge of the area and review substantial findings that help shape, inform and reform our study.

3.1 Prevention of Crop Disease in plants (Groundnut) using IOT and Machine Learning Models.

Yoganand S, Narasinga perumal, Prathap Reddy P, Rahul S.

Plant disease is one of the most vital among the plants which annoys the farmers. In order to help the farmers, it is a vital role to prevent plant disease. If not done then huge amounts of loss will happen to them. To address this problem a naive model is designed for the monitoring of plant disease with help of the sensors. Humidity & Temperature Sensor is deployed to verify the humidity and the atmospheric temperature of the plant. Similarly soil-moisture sensor is deployed to get status of the soil. Sensors, webcam, GSM and micro-controllers are used for receiving the data from the groundnut farm. The received data is analysed using machine learning models and so the prediction of crop disease is done. This novel approach for preventing the crop disease groundnut crop is proposed and the prediction is intimated to farmers through SMS/E-mail.

Components: Temperature and Humidity Sensor, Soil Moisture Sensor, GSM, webcam, Controllers

Methodology:

- The different sensors used are Temperature & Humidity Sensor and Soil Moisture sensor.
- This is finished with the assistance of the GSM module. In programmed mode the microcontroller gets turned ON and OFF consequently while data is analysing.

- Now the crop information collected by the sensors is updated periodically through the controller.
- A GSM module is connected with the micro-controller through which the SMS /E-Mail about the farm condition is sent to the crop owner. Crop monitoring is done where sensors are used to collect information in the groundnut plant.
- The information collected by the sensors is sent to the arduino micro-controller. Crop monitoring is done through web cameras that are used to collect information by capturing images and sent to the arduino micro-controller.

Future work:

- In the future this system can be enhanced with more plant disease detection with the XG Boost algorithm.
- XGBoost is a gradient boosted decision tree which can be used for speed and performance in crop monitoring of plants using ML Algorithms.
- The outline regarding the smart farming system and fixing Soil Moisture Sensors, Temperature & Humidity Sensor and Web Camera to pass the information to Arduino microcontroller via LCD display as SMS/E-Mail.
- Therefore, in future it can be automated for farming using IOT In future the automatic system can be used for irrigation purposes.

Inference: We learnt about using a web camera to monitor the crop and to display the images on LCD Display. And I have got to know about the XG boost algorithm which can be a great use for our project.

3.2 Precision Crop Monitoring with Affordable IOT: Experiences with Okra

Swagatam Bose Choudhury, Prachin Jain

With the increase in population demand for food production increased and thus the demand for higher yields also increased. Precision farming is capable of impacting and revolutionize the farming ecosystem. This Project mainly focuses on Okra in the period oh Kharif season.

Methodology:

- Agrisense gateway collects the sensor data from the farm and sends it to the cloud
- Agrisense mobile is a mobile application that has all the portable sensing needs
- Agrisense node connects to the gateway and mobile using communication protocols such as wifi and zigbee
- Zigbee's data transfer speed is lower than WiFi. Its maximum speed is just 250kbps.
- Zigbee's range is 100mts whereas WiFi covers 300mts
- Kwik Sense is a sensor data acquisition component for integra
- IRIS(Intelligent Rural Integrated Sensing) consists a mobile application for the farmers to check pest levels and a web console for visualization of collected data on the cloud

Future Work:

- Agrisense method used to monitor micro climatic conditions
- The soil moisture sensor helps to make correct irrigation decisions based on the content of the soil and sends a notification to the farmers through iris application.

Inference: We have learnt about collecting the data and send it to cloud through iris mobile application and protocols such as Wi-Fi and Zigbee.

3.3 Intelligent Crop Monitoring and Protection System in Agricultural Fields Using IOT. 2019

Ramaprasad S S, Sunil Kumar B S, Sivaprasad Lebaka, Rajendra Prasad P

In the Agriculture sector water plays an important role in production if we supply water in an unsystematic way that leads to the wastage of water that will also affect the crops yield. This paper mainly deals with providing a scientific way of irrigation system which is based on moisture of the soil. To implement this system we have used Arduino - Microcontroller and sensors such has moisture sensor to monitor the moisture of the land, based on moisture level water pump will turn on or off this helps in saving the water and also monitors the humidity and temperature of agriculture field same information will be sent to the farmer using GSM.

Methodology:

- This system uses Arduino Uno where the soil moisture sensor, DHT 11 sensor and IR sensor are connected to it.
- Solar plant is used as the power supply to back the electricity.
- The information from various sensors is sent to Arduino
- Arduino sends the signal and command to the GSM module and Wi-Fi module based on the information received from sensors.
- By using the GSM module the data is sent to the farmer mobile.

Future work:

As we know that water is a more important resource for human beings, animals and plants, so the water resource should be used in a controlled and efficient way. In the agriculture sector also it requires huge amounts of water, in this particular paper they have implemented an intelligent agriculture system which uses minimal water and gets good yield and productivity. Which is operated measuring many things such as moisture of the soil, Water harvesting, the excess water from the cultivation field which is flown can be recycled back to the tank. The system also helps the farmer with the buzzer when there is an intruder in the farm. The field information is sent to the cloud using Wi-Fi and to the registered mobile using GSM module which helps the farmer to know about his field and what is happening in his absence. They have also used solar energy for the backup purposes. This intelligent irrigation system gets good yield and quality crop, it saves water which flows as excess and also protects from intruders.

Inference: Controlled Usage of water.

3.4 IOT Based Pest Recognition and Control System for Smart Farming. 2019

Dr.C.Chellappan Principal, Jayadhurka.S, JAYALAKSHMI.M, KASTHURI.R

Smart farming is a new concept, using IOT sensors capable of providing information about soil pH, Soil Moisture, Temperature & Humidity.

- Smart Farming can provide effective methods of using fertilizers and other resources to the farmers, thus helping in increase of quality and quantity of crops.
- Early Detection of pests and diseases in crops using IOT does not require an expert human eye, instead we can use IOT to recognise Disease.

Methodology:

- In this paper they have concentrated on an automatic detection system which is required to examine the pest infestation and classify the type of pest.
- There are many numbers of techniques to identify the pest and for the detection of plant diseases. The pest detection in the plant leaf is carried out by the Raspberry pi.
- The insect count is calculated manually by using IR sensor. It is an electronic instrument which is used to sense the certain characteristics of its surrounding by detecting infrared radiation.
- The growth rate of plant can be calculated by using ultrasonic sensor, which is a device that can measure the distance to an object by using sound waves.
- The main advantages of automatic detection system are early detection of the pest reduces the cost and amount of pesticides in crop.

Techniques:

- Image acquisition
- Image processing
- Detection and remedies

Inference: Crops are easily and inevitably damaged by pests, by using image processing we can detect and extract the pest of the crop in early stages.

3.5 Analysis of Classification Algorithms for Plant Leaf Disease Detection. 2019

J. Nithiswara Reddy, Karthik Vinod, A.S. Remya Ajai

Agribusiness is the essential occupation in India that assumes a vital job in the economy of the nation. Yearly 15.7 percentages of the crops are being lost due to attack by insect pests and diseases. The diseases caused will lead to a reduction of quality and quantity of crops. To maintain the health of the plant, it is required to identify the infection and give reasonable consideration. It is difficult to do physically because the human eye cannot observe the minute variations of the infected part of the leaf. In this way, authors have built up a framework programming utilizing mat lab to distinguish plant leaf illnesses by utilizing picture handling procedures. The software is produced so that a man even who doesn't have earlier learning about the plants, and their ailments can effectively recognize infected leaves. We have utilized k-means clustering to distinguish the tainted region of the plant leaf. The diseased recognition part incorporates picture obtaining, image pre-processing, segmentation and feature extraction and SVM classification

CHAPTER-4

PROJECT REQUIREMENT SPECIFICATION

4.1 Introduction

Internet of Things is a concept that allows physical objects with computational and sensor support to connect with each other and access services across the internet. The internet of things idea was introduced to connect devices through the internet and facilitate access to information for users. The wide range of potential applications of internet of things also includes agriculture, where extensive use of internet of things is expected in the future. The aim of this work is to present the internet of things concept as a basis for monitoring and controlling the activities on farms.

4.1.1 Project Scope

- **Aim:** Our Aim is to provide farmers with the information about rainfall, soil nutrition, pest infestation and other farm activities that will help in increase of crop yield and also standards of farming.
- **Benefits :** The Benefits are increase in crop yield, Reduced Resources, Proper utilization resources, Accurate farm and field evaluation, Remote Monitoring
- **Usage:** Farmers.

4.2 Product Perspective

The exponential growth of the human race that means the growth of population, the conventional farming methods are becoming unable to cope up with the growth with satisfaction. Hence advanced farming methods are much needed to approach the necessity of foods for the growing number of people. In the recent few years, smart farming systems based on the Internet of Things are capable of enhancing food production for people.

4.2.1 User Classes:

- **PRECISION FARMING**: The farmers expect to improve, automate and optimize all feasible directions in order to enhance the agricultural productivity and make the cropping system smart.
- **CLIMATE CONDITIONS MONITORING**: It is most important to monitor weather conditions continuously so that future activities can be planned accordingly. Weather parameters which are being monitored include temperature, humidity, wind direction, and air pressure etc..,
- **PEST AND CROP DISEASE MONITORING**: Prediction of crop diseases at early stages helps the farmers to generate more revenue by saving crops from pest attacks.
- **WATER MANAGEMENT**: To measure the exact amount of required water is a key problem.
- Smart sensors are implemented which are controlled by applying multiple IoT techniques to avoid from excessive use of water.
- **PLANT MONITORING**: To create an ideal environment for plants by monitoring the state of plants regularly and generating an alert if any problem is recognizable.
- **SOIL PATTERNS**: Soil monitoring has become one of the most demanding practices in the agriculture field for both industries and farmers.
- In soil monitoring there are many environmental issues which affect crop production.

4.2.2 Operating Environment

4.2.2.1 Hardware requirements

1. ESP32

   ESP32 is a series of low-cost, low-power consumption system on a chip microcontroller which is integrated with the Wi-Fi and dual-mode Bluetooth.

Fig 1 : ESP32

2. Soil Moisture Sensor

   Soil Moisture Sensor is mainly used to measure the volumetric water content in the soil. Where there is a direct gravimetric measurement of soil where it requires removing, drying, and weighing. It measure the water content indirectly by using some of the other soil properties such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content

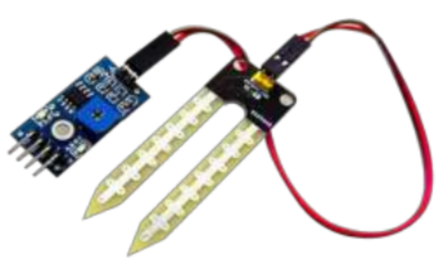


Fig 2: Soil Moisture Sensor

3. PIR Sensor

   PIR motion sensor is used to detect the motion that has been moved around the plant it has 2 slots and it is made up of a special material which is sensitive to IR. It mainly detects the warm body like human, insects or animal passes by.

Fig 3 : PIR Motion Detection Sensor

4. DHT11 Sensor

   DHT11 Temperature and Humidity sensor which used for measuring the humidity and the temperature which uses digital-signal-acquisition and ensures high reliability and stability and also uses NTC temperature measurement component.

Fig 4: Temperature and humidity sensor

5. LDR Sensor

LDR (Light-dependent resistor) sensor is component that decreases resistance with respect to receiving the light (luminosity). Which detect the light if it is exposed to the light it returns the value 1 otherwise 0.

Fig 5 : LDR sensor

6. Barometric Sensor

Barometric pressure sensor is used to detect the atmospheric pressure which gives the value of the atmospheric pressure.

Fig 6 : Barometric sensor

7. IR Sensor

Infrared Sensor is used to detect infrared radiation in its surrounding environment. It returns 0 if the object is detected otherwise it returns 1.

Fig 7: IR sensor

8. Rain Fall Detection Sensor

Rainfall detection sensor which is a kind of switching device which is used to detect a rainfall. It basically work as a switch and working principle is it will be normally closed whenever rain occurs

Fig 8: Rainfall Detection Sensor

9. Smoke Sensor

Smoke sensor is used to sense the smoke and for the indication of the fire which gives an alarm if there is any smoke or fire in the circuit it detects with the alarm.

Fig 9 : Smoke sensor

10. Motor

Motor is used for providing the water to the plants the circuit is designed in such a way that if the soil moisture level is low then the motor gets on automatically it provides the water for 2 seconds and stops the motor.

Fig 10 : Motor

11. GSM Module

GSM modem is a hardware device which uses GSM mobile telephone technology to provide a data link to a remote network with the help of the SIM it sends the message to the ordinary mobile phone. In our project it send the data to the mobile of the soil moisture level, pir motion detected or not and temperature and whether the motor is on these messages will be sent to the mobile phone.

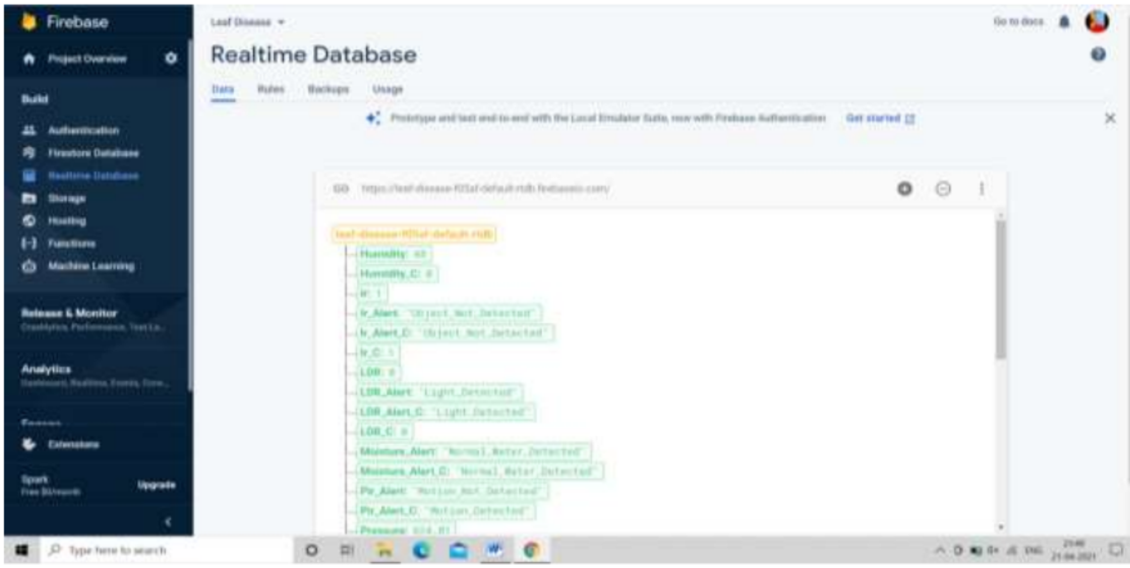
Fig 12: GSM Module

4.2.2.2 System Requirements

1. Google Firebase

Google Firebase is Google backend application development software for building Web, Android and iOS applications. It has real time database, different APIs, multiple authentication types and hosting platform.

- **Real-time Database**: Firebase supports JSON data and all users connected to it receive live updates after every change.



- **Authentication:** We can use password or different social authentications.
- **Hosting:** The applications can be deployed over secured connection to firebase servers.

- Advantages:
  - It is simple and user friendly, no need for complicated configuration.
  - The data is real-time, which means that every change will automatically update connected clients.

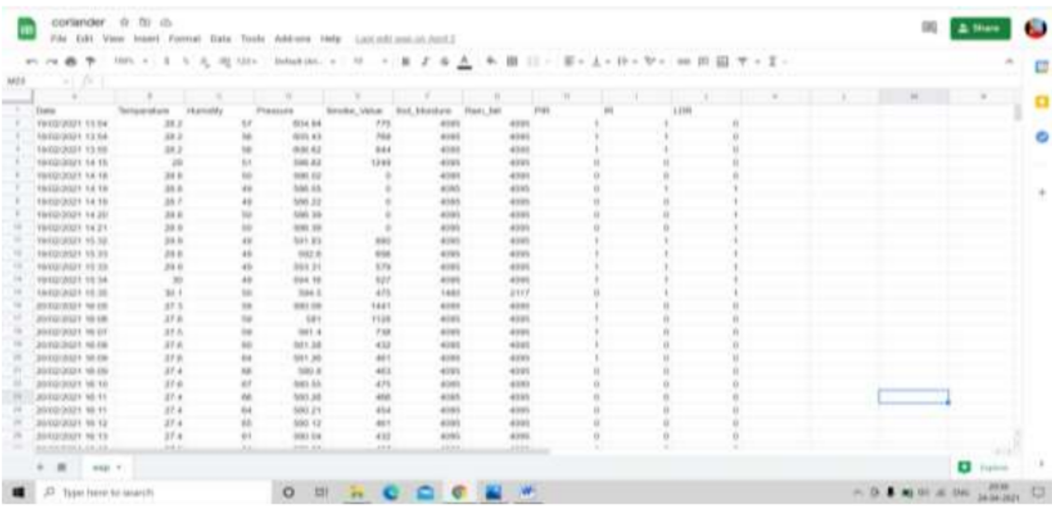
2. Google Sheets

Google sheet is a product of Google that provides the capability of a spread sheet over the cloud. Due its cloud platform it provides more functionality compared to a standard spread sheet. It is a Web-based spread sheet, we can access the data stored on sheets from anywhere via the internet. We can use this as a database also for our small applications or websites. Use Google sheets to store the data and manage it in real-time.

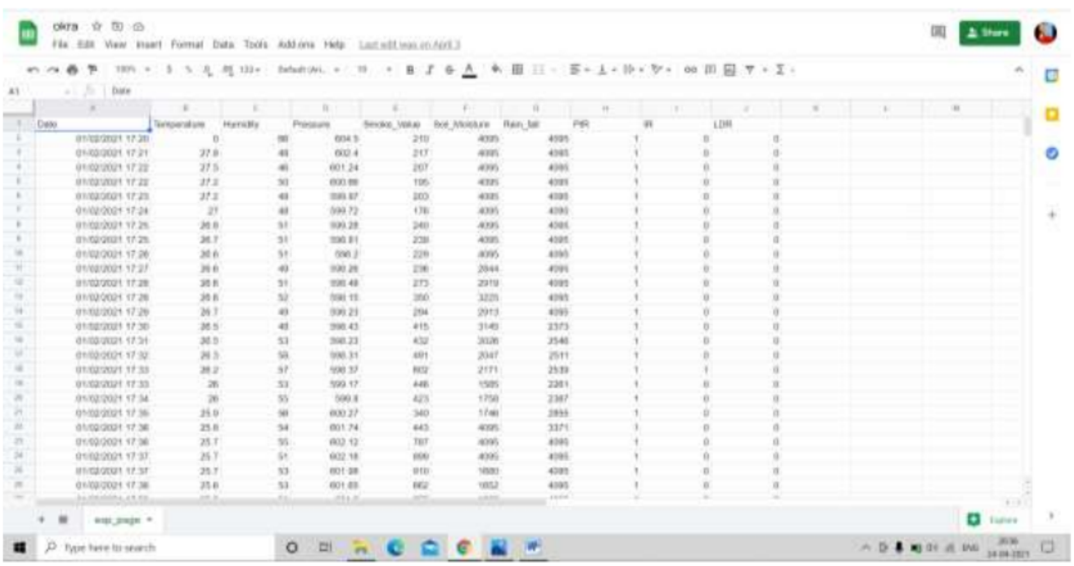
➢ Limitations to using a Google sheet as a database:

- Not fault tolerant - Google sheets are available over the cloud, if any user deletes the spread sheet the complete data will be lost.
- Storage limitations - Google sheet can only store up to 5 million records

1. Coriander Plant Monitored data stored in the Google sheet



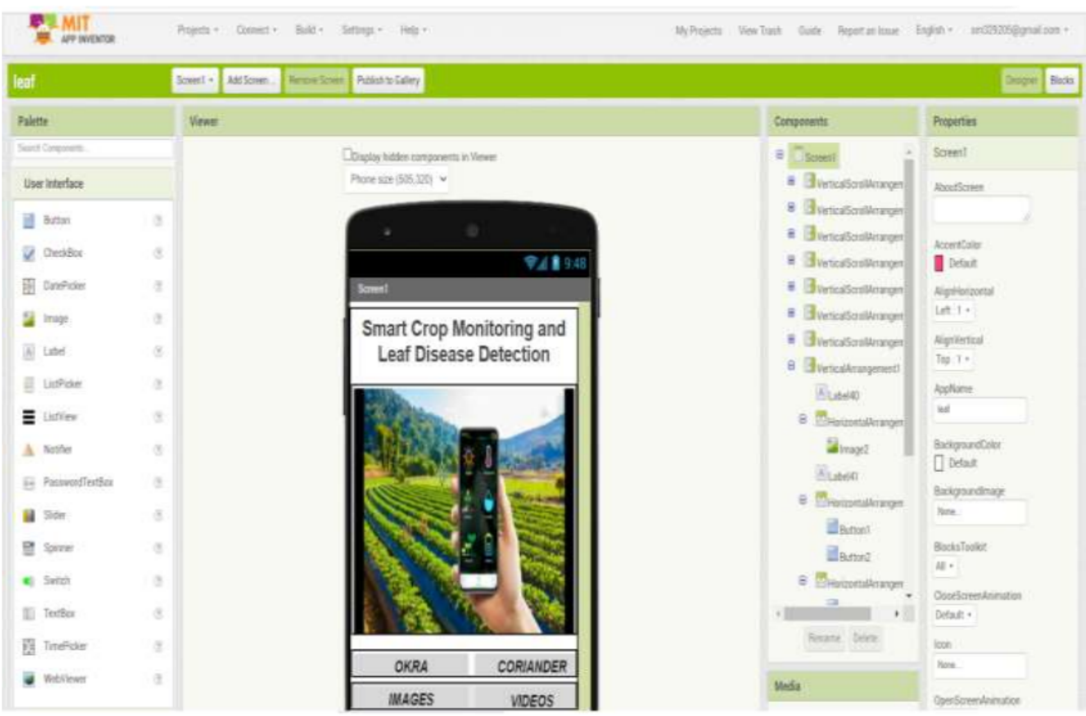
2. Okra Plant Monitored data stored in the Google sheet



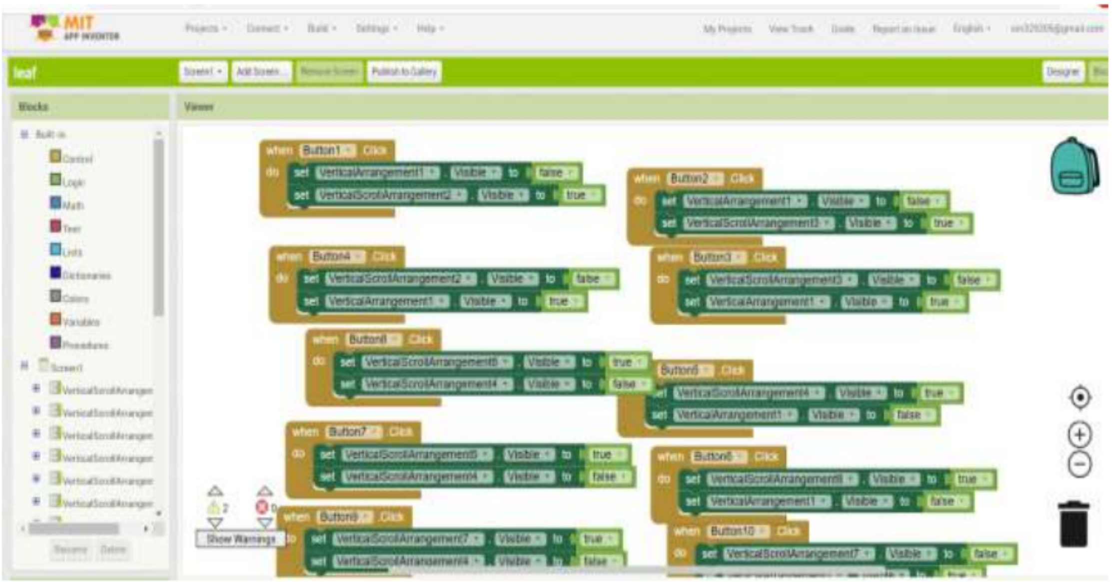
3. MIT App

MIT App inventor is an online development platform. It provides a web based editor for building mobile phone applications targeting the android operating system and it uses a block-based programming language. It includes two main editors: the design editor and block editor. The design editor is drag and drop interface to layout the elements of the application's user interface and the block editor is an environment in which app inventors can visually layout the logic of their apps using color-coded blocks to describe the program. In this we can create applications by dragging and dropping components into a design view and using a visual blocks language to program application behaviour. For development and testing the app inventor provides a mobile app inventor companion

- **Design editor**



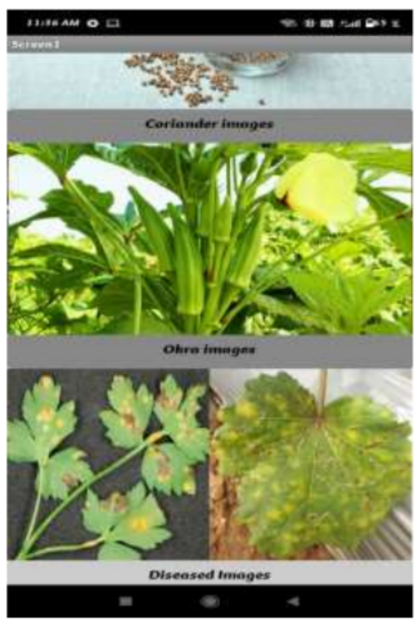
- **Block editor**



- **Home Page**

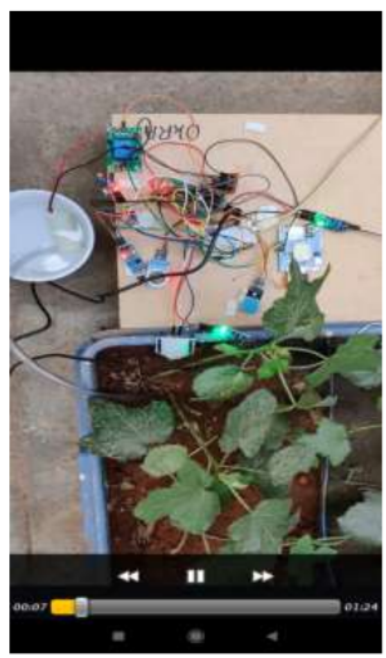
- **Coriander Page and Okra Page**

- **Image Page**



- **Coriander, Okra, Diseased Leaf Images**

- **Videos Page**



2. MATLAB

The MATLAB stands for Matrix Laboratory. MATLAB is written to provide easy software which was developed by LINPACK (linear system package) and EISPACK (Eigen system package) project.

MATLAB is a high performance language which is used for technical computing it also integrates the computation, visualization and the programming. It has embedded with the Data structures and contains multiple built-in editing and also the debugging tools and also supports the object oriented programming.

MATLAB has many of the advantages for solving the technical problems where it is an interactive system without any of the dimensions where the basic element is an array and also has an powerful built-in routines that enable a very wide variety of computations. It also has easy to use the graphics commands that make the visualization of results available immediately.

Specific applications are collected in the packages referred to the toolbox where these toolboxes is used for signal processing ,symbolic computation, control theory, simulation, optimization and several other fields of the applied science and engineering.

In our project we are using MAT LAB for Image processing purpose for LEAF DISEASE DETECTION and ML Algorithm is used for the classification of the leaf disease

Fig: Leaf Disease Detection

- **Image Processing**

Image Processing is a technique which is used to perform some action on the image in order to get the enhanced image or to extract some of the useful information from the leaf in which the image is given as a input and the characteristics and the features that is been extracted image is given back as a output where it converts from rgb to grey scale conversion and also resize the image and it also has the extra features to the user. It mainly has the following steps

- Importing the image from the file.
- Manipulating and also analysing the image.
- Image analysis is given as a result.

In our project it uses digital image processing as it takes image from the required file. Below figure shows the steps for the image processing:

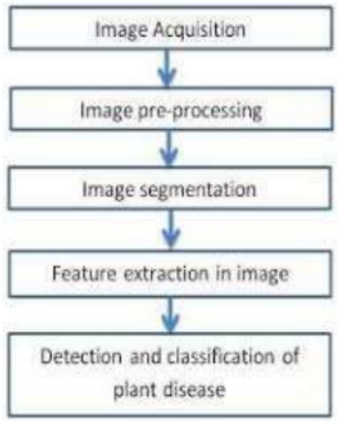


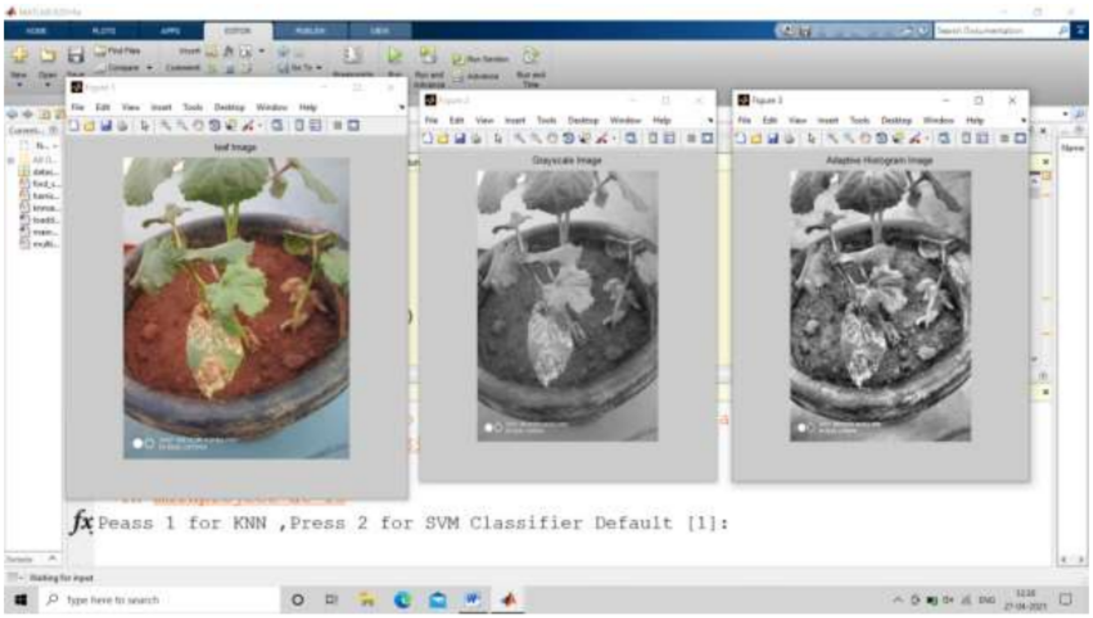
Fig: Steps for image processing

- **Image Acquisition**

Image acquisition is a process of retrieving the image from some source. It mainly accepts the images of .gif, .png, .tif, .bmp formats.

- **Image Pre-processing**

This step is used to visualize the change of the image where it is basically used to resize the image because the images that are captured though the camera that are fed to the algorithm further vary in the size so that we are creating the basic size before feding the image to the algorithm. In this the image is converted to RGB to grey image.



- Image Segmentation

  During image segmentation, the given image is separated into a homogeneous region based on certain features. Larger data sets are put together into clusters of smaller and similar data sets using clustering method. In this proposed work, K-means clustering algorithm is used in segmenting the given image into three sets as a cluster that contains the diseased part of the image. Since we have to consider all of the colours for segmentation, intensities are kept aside for a while and only colour information is taken into consideration. The RGB image is transformed into LAB form (L-luminous, a*b-chromos). Of the three dimensional LAB, only last two are considered and stored as AB. As the image is converted from RGB to LAB, only the "a" component i.e. the colour component is extracted.

  - Algorithm:

    i K number of the cluster should be present always.

    ii In each given cluster, at least one item should be present.

    iii Overlapping of clusters should never happen.

iv Every participant of the single cluster should be close to its own cluster than any other cluster.

- **Process:**

1. The given data set should be divided into K number of clusters and data points need to be assigned to each of these clusters randomly.
2. For each data point, the distance from data point to each cluster is computed using Euclidean distance The Euclidean distance is nothing but the distance between two-pixel points and is given as follows:

   Euclidean Distance=$\sqrt{((x1-x2)^2 + (y1 -y2)^2)}$ where (x1, y1) & (x2, y2) are two pixel points (or two data points).

3. The data point which is nearer to the cluster to which it belongs to should be left as it is.
4. The data point which is not close to the cluster to which it belongs to should be then shifted to the nearby cluster.
5. Repeat all the above steps for entire data points.
6. Once the clusters are constant, clustering process needs to be stopped.

- **Feature Extraction**

From the input images, the features are to be extracted. To do so instead of choosing the whole set of pixels we can choose only which are necessary and sufficient to describe the whole of the segment. The segmented image is first selected by manual interference. The affected area of the image can be found from calculating the area connecting the components. First, the connected components with 6 neighbourhood pixels are found. Later the basic region properties of the input binary image are found. The interest here is only with the area. The affected area is found out. The percent area covered in this segment says about the quality of the result.

The histogram of an entity or image provides information about the frequency of occurrence of certain value in the whole of the data/image. It is an important tool for frequency analysis. The co-occurrence takes this analysis to next level wherein the intensity occurrences of two pixels together are noted in the matrix, making the co-occurrence a tremendous tool for analysis. From grey-co-matrix, the features such as Contrast, Correlation, Energy, Homogeneity' are extracted. The following table lists the formulas of the features.

Using the statistical MATLAB commands the other properties are found out. Those are Mean Standard Deviation, Entropy, RMS, Variance, Smoothness, Kurtosis, Skewness, and IDM.

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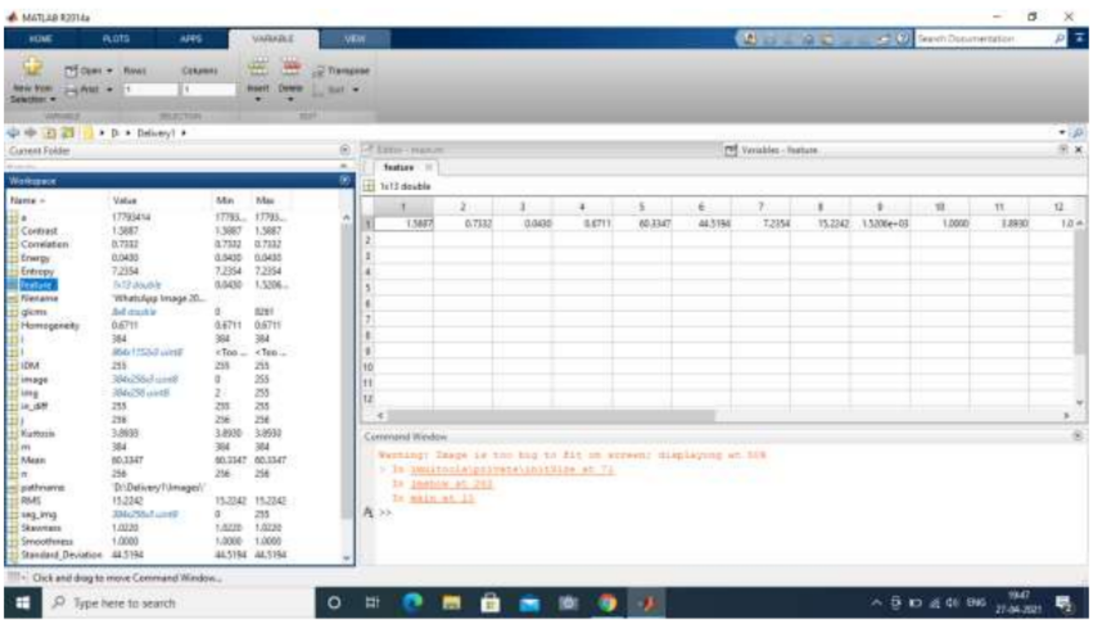


- **Training the data set**

1. Start with images of which classes are known for sure.
2. Find the property set or feature set for each of them and then label suitable.
3. Take the next image as input and find features of this one as new input.
4. Implement the SVM and KNN.
5. Train SVM, KNN. The output will contain the SVM structure and information of support vectors, bias value etc.
6. Find the class of the input image.
7. Depending on the outcome species, the label to the next image is given. Add the features set to the database.
8. Steps 3 to 7 are repeated for all the images that are to be used as a database.
9. Testing procedure consists of steps 3 to 6 of the training procedure. The outcome species is the class of the input image.

- **Classification**

Classification is done using 2 ML algorithms in our project one is SVM and the other is KNN

➢ **SVM**

The binary classifier which makes use of the hyper-plane which is also called as the decision boundary between two of the classes is called as Support Vector machine (SVM). Some of the problems of pattern recognition like texture classification make use of SVM. Mapping of nonlinear input data to the linear data provides good classification in high dimensional space in SVM. The marginal distance is maximized between different classes by SVM. Different kernels are used to divide the classes. SVM is basically binary classifier which determines the hyper plane in dividing two classes. The boundary is maximized between the hyper plane and the two classes. The samples that are nearest to the margin will be selected in determining the hyper plane is called as support vectors.

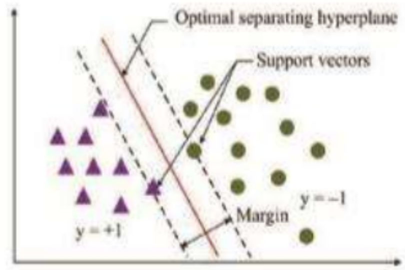
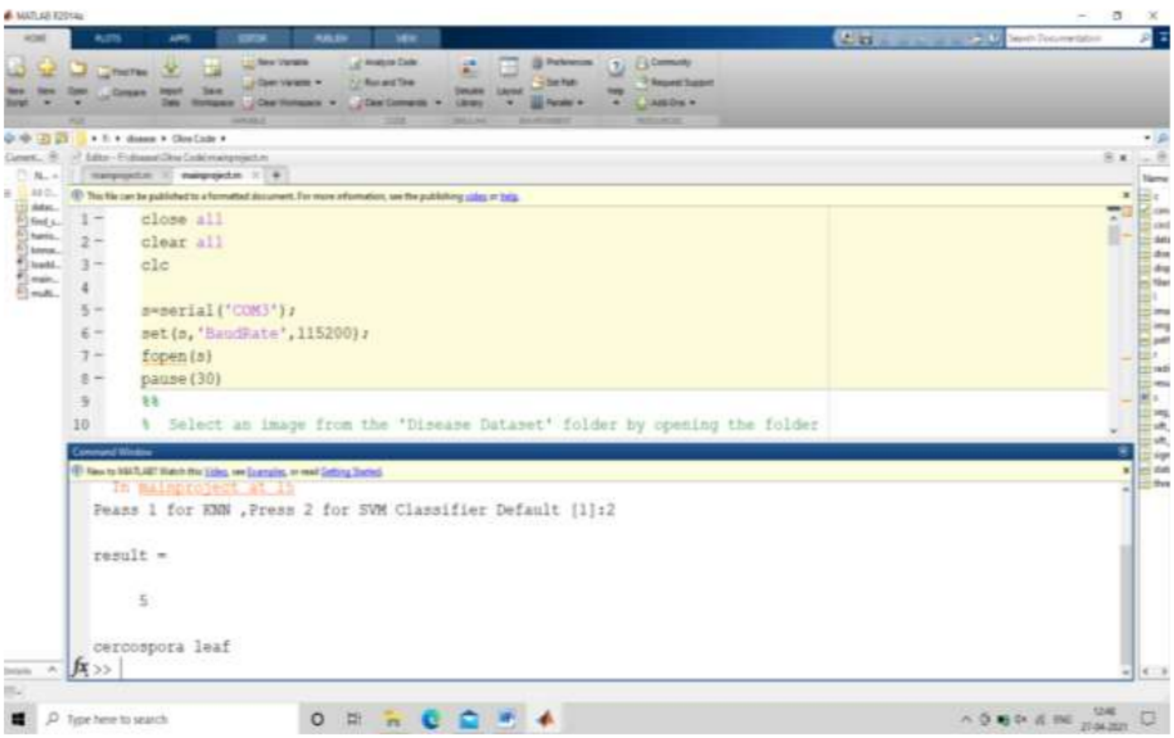
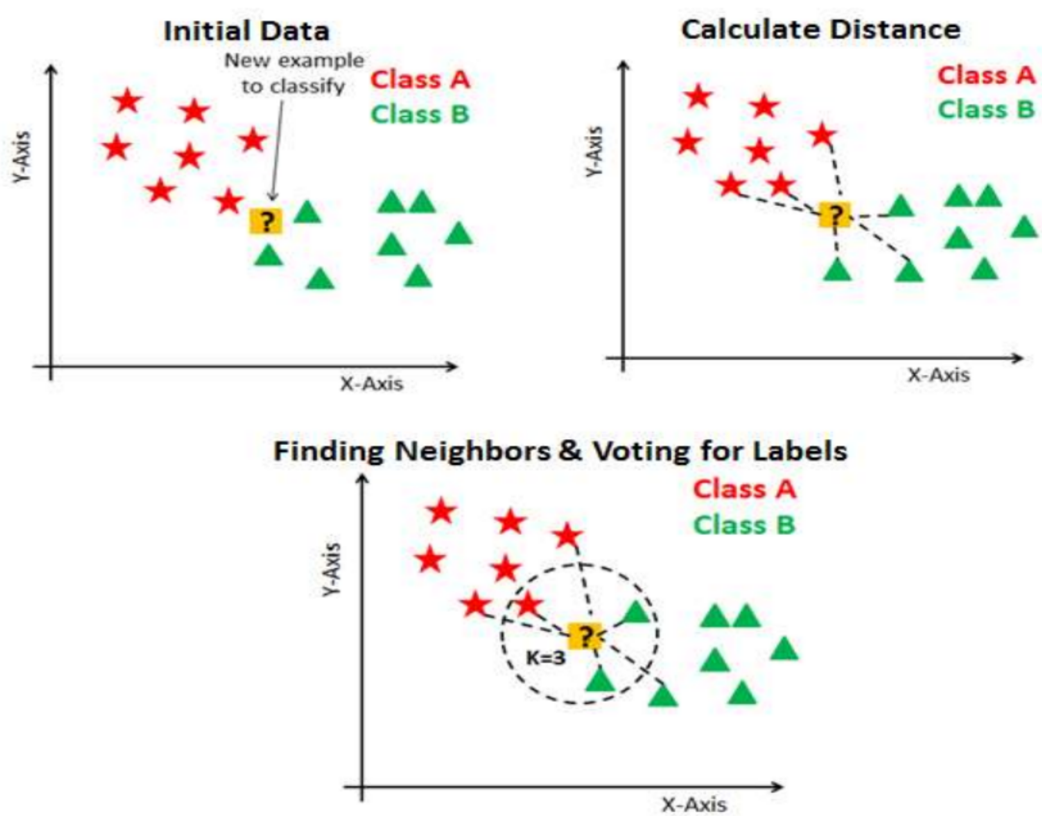

Optimal separating hyperplane
Support vectors
Margin
y = +1
y = −1

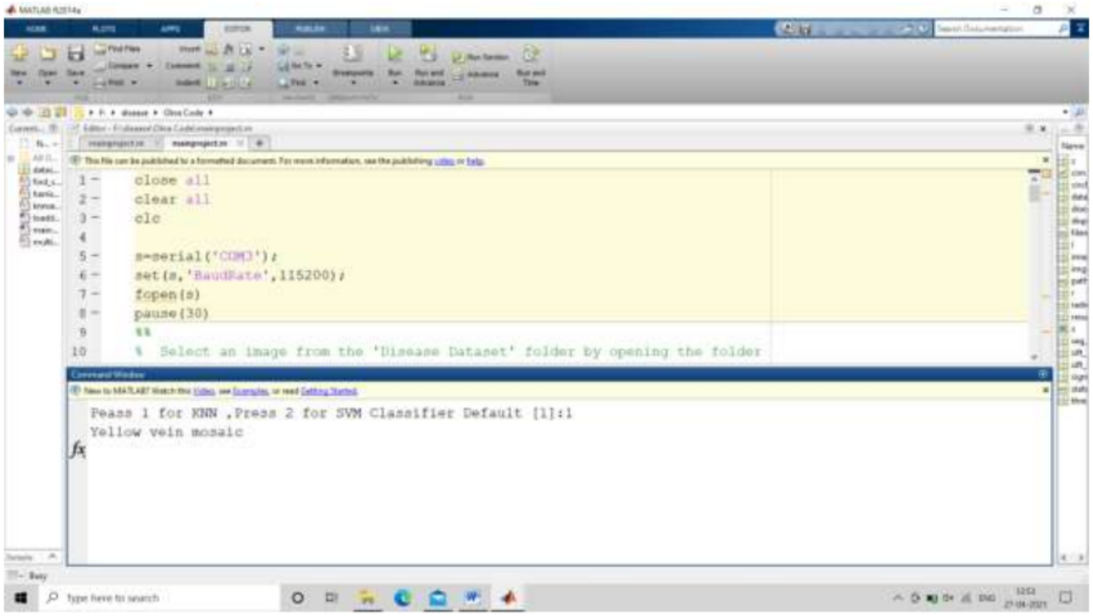
Fig: SVM


close all
clear all
clc
s=serial('COM3');
set(s,'BaudRate',115200);
fopen(s)
pause(30)
%%
% Select an image from the 'Disease Dataset' folder by opening the folder
Command Window
Peass 1 for KNN ,Press 2 for SVM Classifier Default [1]:2
result =
5
cercospora leaf

- **KNN**

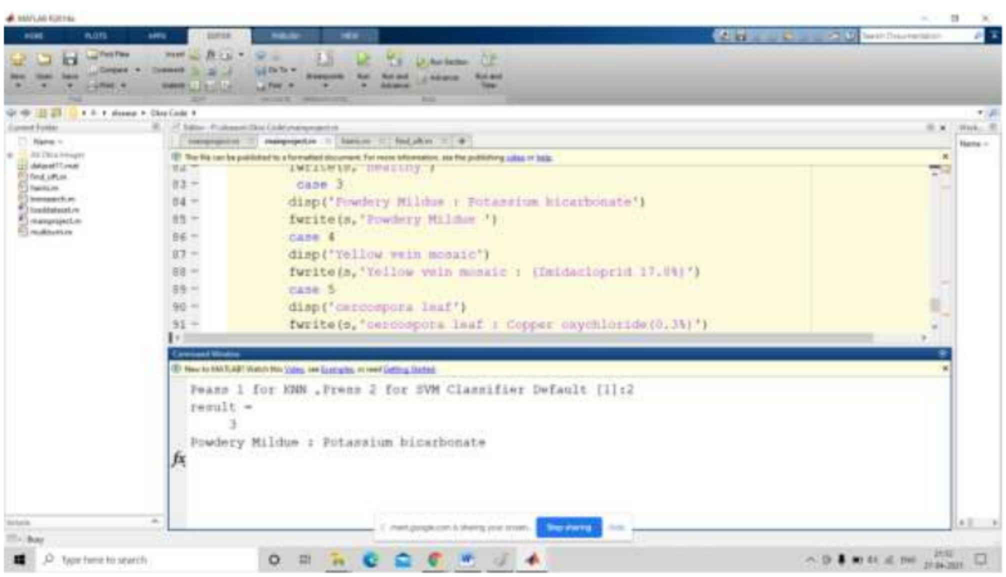
The k-nearest neighbours (**KNN**) **algorithm** is a simple, supervised machine learning **algorithm** that can be used to solve both classification and regression problems. It's easy to implement and understand.

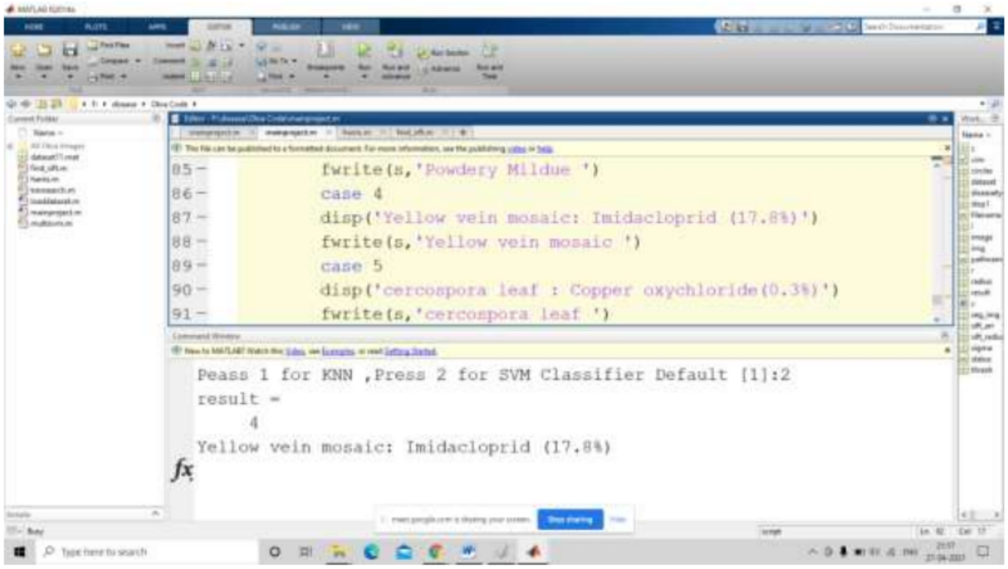




- Pesticides

  In classification if the disease is been detected then it gives the solution for what kind of pesticide should be put for that particular disease manually.





4.2.3 General Constraints, Assumptions and Dependencies

Constraints
Revenue and Affordability
Scalability and Flexibility
Power Consumption
Harsh Device Environment
Robustness and Fault Tolerance

Quality and Availability of Data

4.2.4 Risks

1. THE SECURITY FACTOR
2. TECHNICAL FAILURE AND RESULTANT DAMAGES
3. ENERGY DEPLETION RISK
4. LACK OF SCALABILITY AND CONFIGURATION PROBLEMS
5. MOUNTING E-WASTE
6. CONTEXT-AWARENESS (META DATA)

4.3 Functional Requirements

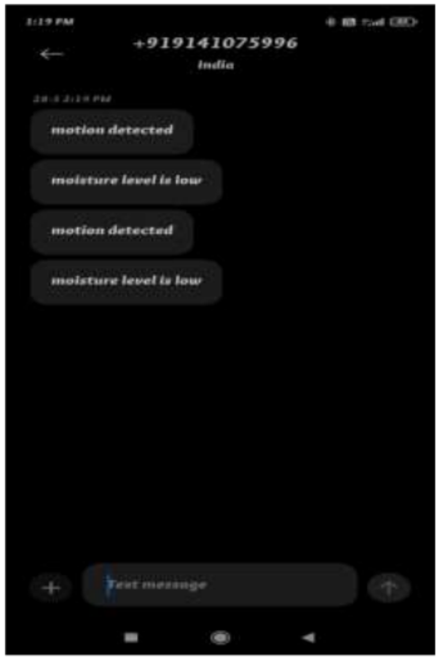
The requirements specify the functions and units of the proposed system. They characterize the behaviour of the system relating to necessity.

- Measure
- Temperature
- Gauge Humidity
- Quantify the water level
- Estimate the light intensity
- Display the sensor readings on the MIT app
- Allow users to modify the optimal values
- Respond to sensor readings and send alerts to the user

4.4 External Interface Requirements

4.4.1 User Interfaces

The system sends an Alert message when any motion, rainfall is detected near the farm and it will also send alert messages when parameters like soil pH, Soil Moisture, Temperature, water level goes below the requirements .



4.5 Non – Functional Requirements

The Non-Functional Requirements of the proposed work assess the following:

- **Availability:** The proposed system is manoeuvred successfully all the time.
- **Reliability:** The system has longer lifespan and the measurements are accurate.
- **Maintainability:** The proposed system can be upgraded at ease by simply integrating additional components with enhanced features.

CHAPTER – 5

SYSTEM DESIGN

This section describes design goals and considerations, provides a high-level overview of the system architecture, and describes the data design associated with the system, as well as the human-machine interface and operational scenarios.

5.1 High Level Design Document

5.1.1 Design Description

- **Physical Implementation**: Building the System using Sensors, Actuators and ESP32 Implementation of Network Equipment
- **System Framework :**
  - **Subsystems**
  - **Sensing**: Collection of Data (environment) through Sensors.
    - **Data Communication**: Communication between the central and wireless sensor nodes communication. Sensor Data is collected into sheets, various Databases, cloud Storage.
  - **Visualisation:** Visualisation, Processing and Manipulation of Data.
- **Data Analysis**: Data is analysed using different algorithms. Through this the system is capable of decision making and execution based on manipulating sensor data.
- **Circuit Design:**
  - **Wireless Sensor Nodes**: Monitoring and Recording the physical conditions of the environment and organizing the collected data at a central location.
  - **Central Node**: central and wireless nodes communication.
    - ➢ Sheets, Various Database, Cloud Storage collect Data.

- **Central Node**: central and wireless nodes communication.
  - Sheets, Various Database, Cloud Storage collect Data.
  - Decision making and execution is done by manipulated sensor data.
  - Information is gathered through different sensors and sent to servers by wireless sensor networks.
  - Data-information about ecological conditions so this is done to design the framework appropriately.
  - There are many factors other than just observing ecological conditions, yield productivity for assessment of harvest, factors like monitoring soil conditions, movement like outsider invasion into the field or motion of undesired objects are some which might also have effect on productivity.
  - Using IOT based Smart Farming techniques we can limit assets and ensure best utilisation to improve productivity.

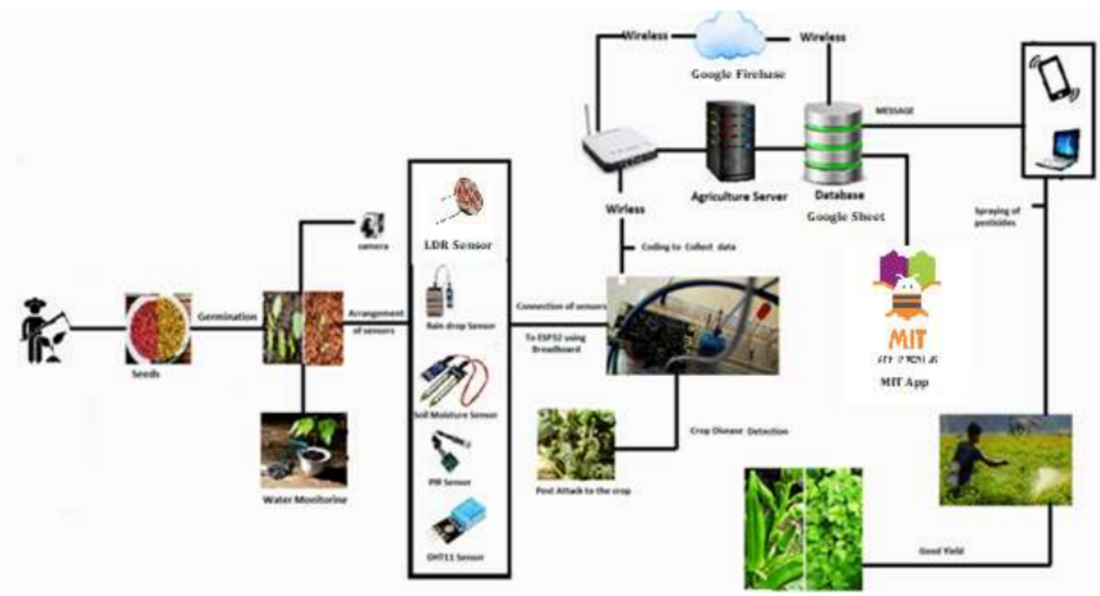
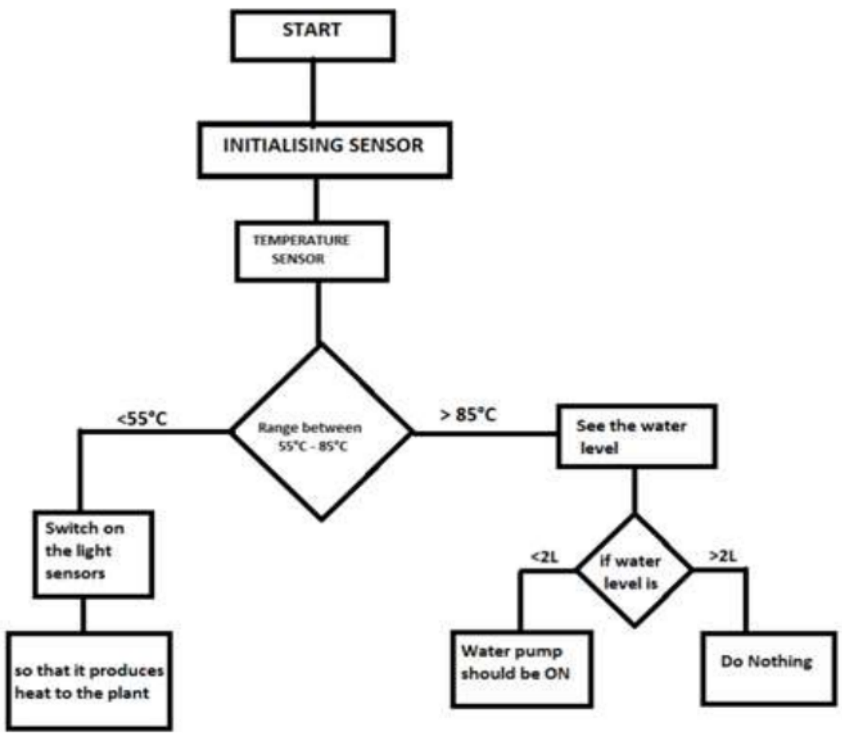


Fig: High Level System Design

High level system design the farmer will plant the seeds to the pot then germination happens then the plants will be monitored using the sensors and even the water required level will be monitored using the automatic water pumping technology the sensors will be connected to the ESP32 using wired connection the data will be stored in ESP32 then the data will be sent to the cloud by the wireless connection by making the connection through the cloud and the data will be stored in the database. By the usage of the image sensor the plants will be monitored if any disease attacked to the plants and the data will be stored and the message will be sent to the farmer using GSM module so that if any disease has been detected he can spray the pesticides manually.



It finds any leaf diseases it will indicate the farmer regarding the disease through the built application so that he can take care of the plants, Mainly the data is stored on the database through the cloud & through the GSM module the signal or message is sent farmer mobile regarding the indication of the plants health.

Leaf Disease Detection is done by capturing the images of the leaf or using the pre-existing dataset and implementing ML algorithms such as KNN, Neural Networks and Image Processing.

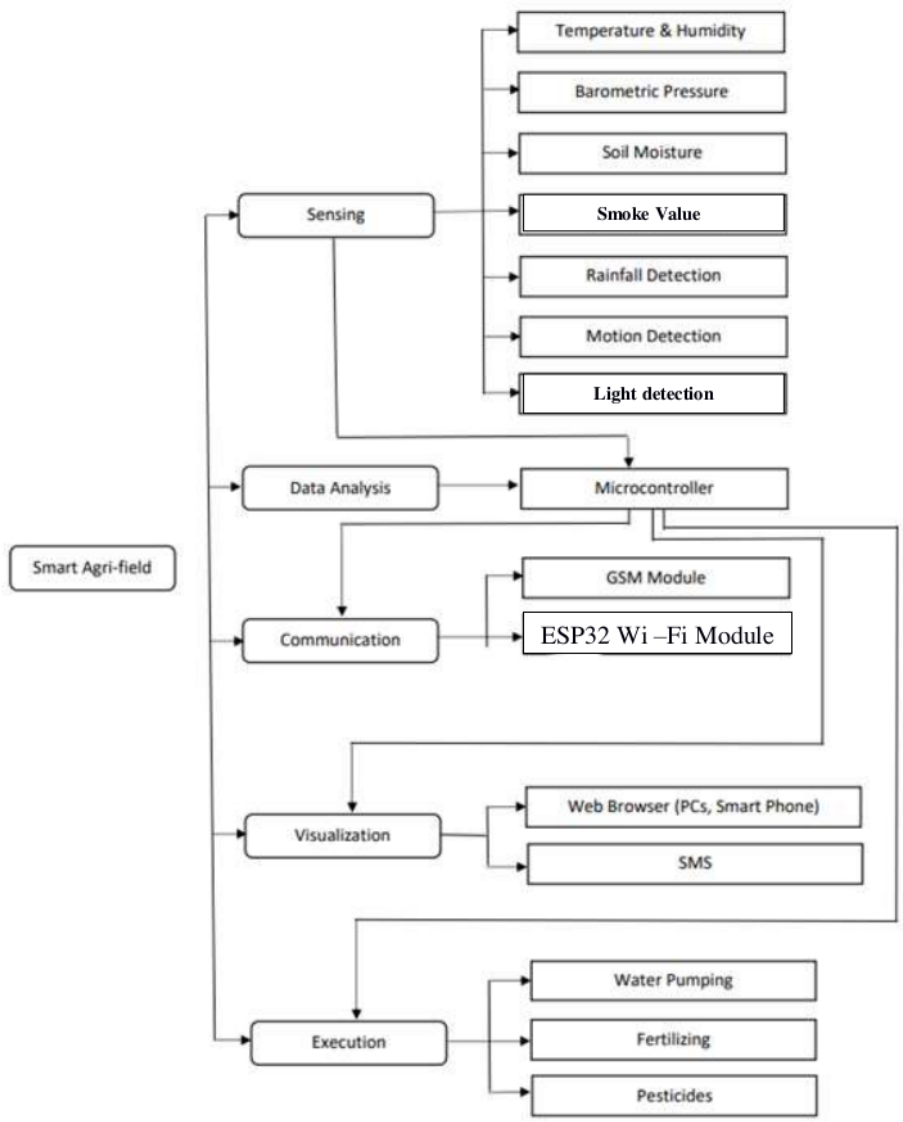


Fig: Flow chart of complete prototyping Framework

CHAPTER – 6

PROPOSED METHODOLOGY

The proposed system consist of monitoring of crops, displaying the data in the Cloud, storing the data in Google sheets, MIT app for the updating the status of the particular crop in the mobile by using an app, MAT LAB is used for the image processing and Machine Learning techniques is used for the Classification of the leaf diseases and spraying the pesticides.

- **Monitoring of crops**

For monitoring of okra and coriander we have used 8-9 sensors they are soil moisture sensor which is used to check the moisture level (water content) of the soil, Rainfall detection sensor is used to detect the rain, PIR and IR sensors are used to detect the motion such as any insects or any human being that is passed around the crop, Smoke sensor is used to detect the fire or smoke that occurs due to some calmative's or if there is any short circuit in the circuit, LDR sensor is used to detect the light it specifies the required light value is sufficient for the plant or not, Barometric sensor is used to measure the atmospheric pressure and finally Temperature and humidity sensor is used to check the current temperature that helps the plant to grow and then finally motor is used to pour the water to the plant it is designed in such a way that if the moisture level or water content in the soil reduces the motor should get ON it pours the water to the plant for 2 seconds and again checks the moisture level if the moisture level is greater than 2000 then the motor stops.

All these sensors code is dumped in ESP32 all these sensors are connected to the ESP32 which is Wi-Fi connected and it also connects to the power supply where it provides the connection for all the sensors. We have used Embedded C language in Arduino IDE for the connection of sensors.

GSM module is used to send the messages to the particular user in our project we are sending 3 messages to the user. the moisture level of the plant, motion detection, and leaf disease detection if any motion or disease has been occurred to the plant that messages will be sent to the user.

- Cloud Platform

  Here we make use of “FIREBASE” as our cloud platform where it is used to view the data in the cloud where it can have multiple conditions such here we set the users as viewer, editor, owner where viewer can only view the data editor can edit the names of the key but cannot change the values manually and owner can set the viewers and editors. It is basically used for the DATA VISUALIZATION where all the sensors data is been viewed according to the monitoring of the plant.

- Google Sheets

  It is a Web-based spread sheet, we can access the data stored on sheets from anywhere via the internet. We can use this as a database also for our small applications or websites. Use Google sheets to store the data and manage it in real-time. Google sheets are used to store the data that are monitored and viewed in the cloud. Which helps to store the data for every loop as soon as the monitoring is done with day to day update.

- MIT App

  MIT App inventor is an online development platform. It provides a web based editor for building mobile phone applications targeting the android operating system and it uses a block-based programming language. It includes two main editors: the design editor and block editor. The design editor is drag and drop interface to layout the elements of the application’s user interface and the block editor is an environment in which app inventors can visually layout the logic of their apps using color-coded blocks to describe the program. In this we can create applications by dragging and dropping components into a design view and using a visual blocks language to program application behaviour. For development and testing the app inventor provides a mobile app inventor companion and using MIT APP it helps the user to view the data and images through the mobile.

- MAT LAB

The MATLAB stands for Matrix Laboratory. MATLAB was written originally to provide easy access to matrix software developed by the LINPACK (linear system package) and EISPACK (Eigen system package) projects. MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming environment. It has sophisticated data structures, contains built-in editing and debugging tools, and supports object-oriented programming. In our project we are using MAT LAB for Image processing purpose for LEAF DISEASE DETECTION and ML Algorithm is used for the classification of the leaf disease.

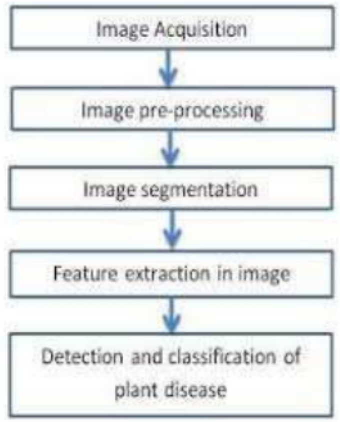
  - Image Processing

Image processing is a method which is used to perform some operations on the image in order to get an enhanced image or to extract some useful information from the leaf in which image is given as a input and the characteristics and the features of the extracted image is given back as a output to the user. It mainly includes the following steps :

- Importing the image.
- Manipulating and analysing the image.
- Image analysis is given as a result.

In our project it uses digital image processing as it takes image from the required file.

Below figure shows the steps for the image processing :



All these steps are been carried for image processing and leaf disease detection firstly the image is been selected then it is resized for the standard size the RGB to gray scale conversion is done then it takes the key points of the image then future extraction is done the data is been trained then the classification of the disease is been done using ML algorithms which is KNN and SVM. If the disease is been detected then it also says which pesticide has to be sprayed but the pesticides has to be put manually.

- ML Techniques

  ML algorithms are used for the classification of the leaf disease we are using 2 algorithms for the classification to check the accuracy.

  - KNN

    The k-nearest neighbours (KNN) algorithm is a simple, supervised machine learning algorithm that can be used to solve both classification and regression problems. It is easy to implement and understand.

- Algorithm of KNN
    - Select the number K of the neighbour
    - Calculate the Euclidean distance of K number of neighbours
    - Take the K nearest neighbours as per the calculated Euclidean distance.
    - Among these k neighbours, count the number of the data points in each category.
    - Assign the new data points to that category for which the number of the neighbour is maximum.

- SVM

The binary classifier which makes use of the hyper-plane which is also called as the decision boundary between two of the classes is called as Support Vector machine (SVM). Some of the problems of pattern recognition like texture classification make use of SVM. Mapping of nonlinear input data to the linear data provides good classification in high dimensional space in SVM. The marginal distance is maximized between different classes by SVM. Different kernels are used to divide the classes. SVM is basically binary classifier which determines the hyper plane in dividing two classes. The boundary is maximized between the hyper plane and the two classes. The samples that are nearest to the margin will be selected in determining the hyper plane. are called as support vectors.

- Algorithm for SVM
    - Import the dataset.
    - Explore the data to figure out what they look like.
    - Pre-process the data.
    - Split the data into attributes and labels.
    - Divide the data into training and testing sets.
    - Train the SVM algorithm.

By using all these technology we are designing smart crop monitoring and leaf disease detection using IOT with the better accuracy which helps the farmer to make his work easier.

CHAPTER – 7

IMPLEMENTATION AND PSEUDO CODE

Step-1: Connecting Hardware Components.

- Hardware Components such as sensors, Actuators, ESP32 and GSM Module

Step-2: Collecting Environmental Data from the sensors

Step-3: Storing the Data in Cloud (AWS)

Step-4: Analysing the Environmental Data

Step-5: Sending the alert messages to the user through GSM Module

Step-6: Detection of Leaf Disease

Step-7: Spraying the Pesticides Manually

PSEUDO CODE :

- ESP 32 connection

```
#ifndef ESP32
#pragma message (THIS EXAMPLE IS FOR ESP32 ONLY!)
#error Select ESP32 board.
#end if
```

- Soil Moisture Sensor

```
void soilsensor()
{
  Soilvalue = analogRead(35);
  Serial.print ("Soil value :");
  Serial.println(soilvalue);
  Firebase.setFloat("Soil", soilvalue);
```

```
if(soilvalue > 3000)
 {
  Serial.print("Normal Detected");
  SendMessage2();
  Firebase.setString("Moisture_Alert", "Normal_Water_Detected");
  digitalWrite(relay, HIGH);
  SendMessage3();
  delay(2000);
  digitalWrite(relay, LOW);
 }
 else
 {
  Serial.print("High Water Detected");
  Firebase.setString("Moisture_Alert", "High_Water_Detected");
  digitalWrite(relay, LOW);
 }
  Serial.println();
}
```

- PIR Motion Detection Sensor

```
void pirsensor()
{
 Pirvalue = digitalRead(pir);
 Serial.print("Pir value :");
 Serial.println(pirvalue);
 Firebase.setFloat("pir",pirvalue);
 if(pirvalue == 1)
 {
  Serial.print("Motion Detected");
  SendMessage1();
```

```
Firebase.setString("Pir_Alert", "Motion_Detected");
 }
 else
 {
  Serial.print("Motion Not Detected");
  Firebase.setString("Pir_Alert", "Motion_Not_Detected");
 }
 Serial.println();
}
```

- DHT11 Sensor

```
bool getTemperature() {
 TempAndHumidity newValues = dht.getTempAndHumidity();
 if (dht.getStatus()!= 0) {
  Serial.println("DHT11 error status: " + String(dht.getStatusString()));
  return false;
 }
 float heatIndex = dht.computeHeatIndex(newValues.temperature,
newValues.humidity);
 float dewPoint = dht.computeDewPoint(newValues.temperature, newValues.humidity)
 float cr = dht.getComfortRatio (cf, newValues.temperature, newValues.humidity);
 Serial.println();
 Serial.print("Temperature:");
 Serial.println(String(newValues.temperature));
 Serial.print("Humidity:");
 Serial.println(String(newValues.humidity));
 Tempi=newValues.temperature;
 Humii=newValues.humidity;
 return true;
}
```

- LDR Sensor

```
void ldrsensor()
{
 Ldrvalue = digitalRead(ldr);
 Serial.print("LDR value:");
 Serial.println(ldrvalue);
 Firebase.setFloat("LDR",ldrvalue);
 if(ldrvalue==1)
 {
  Serial.print("Dark Detected");
  Firebase.setString("LDR_Alert", "Dark_Detected");
 }
 else
 {
  Serial.print("Light Detected");
  Firebase.setString("LDR_Alert", "Light_Detected");
 }
 Serial.println();
}
```

- Pressure Sensor

```
void pressure() {
 char status;
 bool success = false;
 status = bmp180.startTemperature();
  if (status != 0) {
   status = bmp180.startPressure(3);
   if (status != 0) {
    delay(status);
    status = bmp180.getPressure(P, T);
```

```
          if (status != 0) {
            Serial.print("Pressure: ");
            Serial.print(P);
            Serial.println(" hPa");
            Firebase.setFloat("Pressure",P);
          }
        }
      }
    }
```

- IR Sensor

```
void irsensor()
{
  Irvalue = digitalRead(ir);
  Serial.print("Ir value:");
  Serial.println(irvalue);
  Firebase.setFloat("Ir",irvalue);
  if(irvalue==0)
  {
    Serial.print("Object Detected");

    Firebase.setString("Ir_Alert", "Object_Detected");
  }
  else
  {
    Serial.print("Object Not Detected");
    Firebase.setString("Ir_Alert", "Object_Not_Detected");
  }
  Serial.println();
```

```
}
```

- Rainfall Detection Sensor

```
void rainsensor()
{
 rainvalue=analogRead(32);
 Serial.print("Rain value:");
 Serial.println(rainvalue);
 Firebase.setFloat("Rain",rainvalue);
 if(rainvalue<1700)
 {
  Serial.print("Rain Detected");
  Firebase.setString("Rain_Alert", "Rain_Detected");
 }
 else
 {
  Serial.print("Rain Not Detected");
  Firebase.setString("Rain_Alert", "Rain_Not_Detected");
 }
 Serial.println();
}
```

- Smoke Sensor

```
void smokesensor()
{
 Gasvalue = analogRead(34);
 Serial.print("Smoke value:");
 Serial.println(gasvalue);
 Firebase.setFloat("Smoke",gasvalue);
 if(gasvalue > 1200)
```

```
    {
     Serial.print("Smoke Detected");
     Firebase.setString("Smoke_Alert", "Smoke_Detected");
    }
    else
    {
     Serial.print("Smoke Not Detected");
     Firebase.setString("Smoke_Alert", "Smoke_Not_Detected");
    }
    Serial.println();
   }
```

- Motor Connection

```
void temperature()
{
    if (!tasksEnabled) {
    delay(2000);
    tasksEnabled = true;
    if (tempTaskHandle != NULL) {
      vTaskResume(tempTaskHandle);
    }
  }
  yield();
}
```

- GSM Module Connection

```
void setup()
{
  Serial.begin(115200);
  gsm.begin(9600);
```

```
WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
Serial.print("connecting");
while (WiFi.status() != WL_CONNECTED) {
Serial.print(".");
delay(500);
}
Serial.println();
Serial.print("connected: ");
Serial.println(WiFi.localIP());
}
```

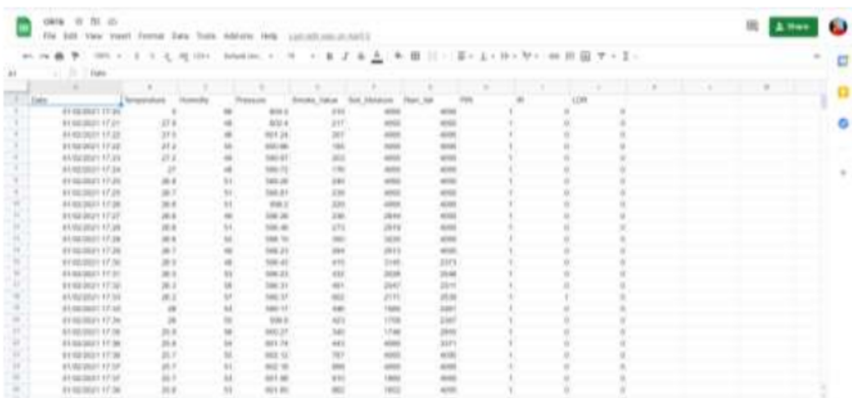
CHAPTER – 8

RESULT AND DISCUSSION

In this project the analysis of the results is comprised into two parts i.e. Crop monitoring and visualizing the data in Google firebase and storing the data in the Google sheets the other is Mat Lab Comparison with the algorithms and image processing for the detection of the leaf disease.

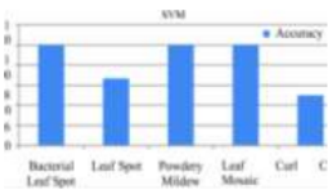
Crop monitoring:

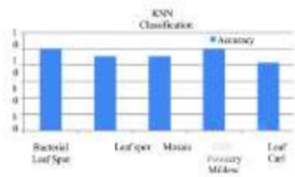
In this module it monitors the complete crop or plant with the help of the sensors and store the data in the Google sheets and the data is visualized in Google Firebase.

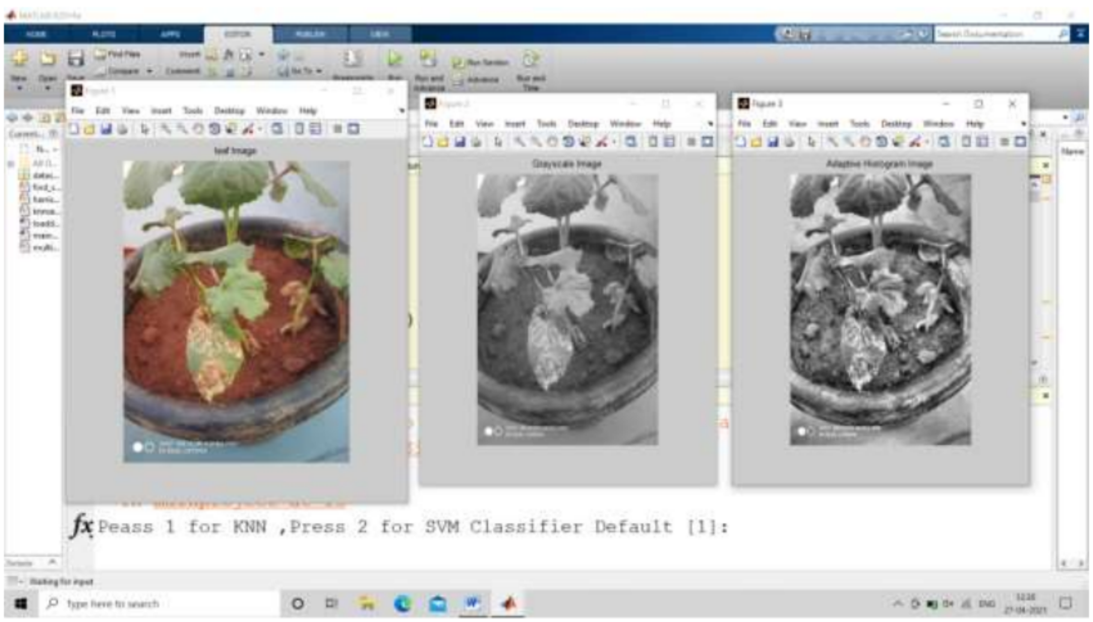


Mat Lab:

Mat lab is used for image processing where the images of the plant is been captured in the mobile and that image is trained with the help of algorithm and accuracy of the SVM and KNN is checked with different diseases.







CHAPTER – 9

CONCLUSION AND FUTURE WORK

There are no limitations on how many connections and sensors can be set up in an IOT agricultural smart system. The discussed model and IOT system design explored in this project can be implemented in a small setting like a backyard garden, in-door garden and even on a large-scale farm. All the components and design can be scaled to meet the user's needs. However, it should be noted that the smart farming (as an application of IOT technology) has not been given much attention and sufficient research. This is basically happened because many of the farming operations usually occur in the remote areas. But given more attention especially from countries with much agriculture exports, the smart farming has the potential to revolutionize the way farms operate and hence to boost the food market around the world.

For further research and study, we can develop and integrate an automatic mode for the system. That is a farmer who can set his farms in an "Auto-Mode" that allows him not only monitor the farm and collect data, but also take automatically some present actions basing on the collected data. Furthermore, the system can be incorporated with USSD functionality to implement an offline action control mechanism for farm management. This is relevant to farmers in remote areas where the internet connection is weak, or smart phones are not in use or not preferred. Collection of the dataset and water storage can be done if it rains heavily and that water can be recycled. In our project we have been used two algorithms which is SVM and KNN and got the accuracy of 98% you can also try with any other algorithms to increase the efficiency and accuracy.

Smart Crop Monitoring and Plant Disease Detection

ORIGINALITY REPORT

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PRIMARY SOURCES

1	Abbas Shah Syed, Daniel Sierra-Sosa, Anup Kumar, Adel Elmaghraby. "IoT in Smart Cities: A Survey of Technologies, Practices and Challenges", Smart Cities, 2021 Publication	4%
2	Swagatam Bose Choudhury, Prachin Jain, Sujal Kallamkuth, Saranya Ramanath, Prakruti V. Bhatt, Sanat Sarangi, P. Srinivasu. "Precision Crop Monitoring with Affordable IoT: Experiences with Okra", 2019 Global IoT Summit (GIoTS), 2019 Publication	1%
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