SMART GARDENING AND PLANT DISEASE DETECTION USING LoRaWAN

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APJ Abdul Kalam Kerala Technological University

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Certificate

This is to certify that the project report entitled "Smart Gardening and Plant Disease Detection Using LoRaWAN" is a bonafide record of the work done by **Afroos Shahana.T (MEA17IT002),Fathima Nida(MEA17IT006),Muhammed Anas.K (MEA17IT007),Swalih.T(MEA17IT011)** *under our supervision and guidance. The report has been submitted in partial fulfillment of the requirement for award of the Degree of* **Bachelor of Technology** *in* **Information Technology** *from the APJ Abdul Kalam Kerala Technological University for the year 2021.*

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Abstract

Our project is the integration of home gardening, plant disease detection using IOT. Plants are being destroyed each and every day for urbanization process. The number of plantings made is also reduced. Apart from these things more plants die due to lack of maintenance. The main aim of this project is to maintain the nature of the plants by continuously monitoring the parameters leading to the increased life of plants. The automatic systems are preferred to a manual system. Identification of plant disease is key to preventing the losses in the yield of plant product which is difficult to do manually. The project therefore involves a system architecture which allow user to achieve all above activities in real time. It includes A module placed in a garden that contains various sensors and device for data conversion and transfer such that garden details and environmental factors are monitored and controlled correctly Image processing for disease detection of visually seen symptoms of plant. Using an application the treatment is suggested to reduce the damage levels.Disease detection from the images of the plant leaf, fruit is one of the interesting research areas in agriculture field. This field needs a reliable prediction methodology to detect factors influencing disease. Machine learning is the process of analyzing data from different aspects and summarizing it into valuable information. It allows users to analyze data from different dimensions, categorize and the relationships are identified. WEKA is a data analysis tool for machine learning classification. Machine learning classification is a vital technique with more applications in various fields. It is used to classify each item in a set of data into one of predefined set of classes. In this paper present a different image processing and machine-learning techniques used for the identification of plant diseases based on images of disease infected plants. The proposed work focus on machine learning techniques with Naïve Bayes, Multilayer Perceptron for predicting disease using WEKA tool. This is including size of image dataset, preprocessing, segmentation techniques, types of classifiers.

Contents

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List of Abbreviations

IOT	INTERNET OF THINGS
LoRaWAN	LONG RANGE WIDE AREA NETWORK
GSM	GLOBAL SYSTEM FOR MOBILE COMMUNICATION
PC	PERSONAL COMPUTER
SMS	SHORT MESSAGE SERVICE
SIM	SUBSCRIBER IDENTITY MODULE
ANN	ARTIFICIAL NEURAL NETWORK
WEKA	WAIKATO ENVIRONMENT FOR KNOWLEDGE ANALYSIS

CHAPTER 1

INTRODUCTION

Internet of Things means Internetworking of physical devices which are embedded .It creates an opportunity about direct interaction of physical world with computer system world .Agriculture is the backbone and one of the important human activity of our nation.In agricultural sector, water is the most used resource. Irrigation helps to save large amount of water.Manual irrigation is the traditional method used in agricultural land and may require expert labours on larger farm. In this work, an automated smart irrigation system along with plant disease and fruit maturity detection using IOT.Image processing for disease detection of visually seen symptoms of plant Using an application the treatment is suggested to reduce the damage levels.

India is the largest freshwater user in the world, and the country's total water use is greater than any other continent. The agricultural sector is the biggest user of water, followed by the domestic sector and the industrial sector. Groundwater contributes to around 65 percentage of the country's total water demand and plays an important role in shaping the nation's economic and social development. The requirement of building an automation system for an office or home is increasing day-by-day. Automation makes an efficient use of the electricity and water and reduces much of the wastage. The need of automated irrigation system is to overcome over irrigation and under irrigation. Over irrigation occurs because of poor distribution or management of waste water, chemical which leads to water pollution. Under irrigation leads to increased soil salinity with consequent buildup of toxic salts on the soil surface in areas with high evaporation. Another problem faced is plant diseases during growth, due to the unpredictable climatic changes, there is lack of nutrients and minerals to the crops. This leads to deficiency diseases which in turn affects the crop productivity.

Plants get affected not only due to deficiency but also caused due to micro-organisms like fungi, bacteria, virus and mites. This kind of borne diseases are very dangerous as they affect large farming. And so, it is very important to take steps for maintaining the crops. Manual observation over the health of the crops might result in errors and may even be difficult in case of large acres of land. Generally, whenever there is disease to a plant, we can say that leaves are the main indicator of the disease caused to the plant. Mostly we can see the spots on the leaves of it due to disease. However, when the amount of disease to the plant is large then the whole leaf gets covered by the disease spots. With the help of sensors and GSM shield, controlled by Raspberry Pi 3 microcomputer, we designed a system to automatically sprinkle accurate amount of water by detecting soil moisture, daylight intensity, water level and warn the administrator about intruder or plant disease through SMS or Email. In a Smart Irrigation System, the Raspberry pi is combined with Cloud Computing to provide the communication between the person and the system. Cloud is a service provider or a type of internet-based computing that provides shared computers processing resource and other devices on demand.

Disease detection from the images of the plant leaf, fruit is one of the interesting research areas in agriculture field. This field needs a reliable prediction methodology to detect factors influencing disease. Machine learning is the process of analyzing data from different aspects and summarizing it into valuable information. It allows users to analyze data from different dimensions, categorize and the relationships are identified. WEKA is a data analysis tool for machine learning classification. Machine learning classification is a vital technique with more applications in various fields. It is used to classify each item in a set of data into one of predefined set of classes. In this paper present a different image processing and machine-learning techniques used for the identification of plant diseases based on images of disease infected plants. The proposed work focus on machine learning techniques with Naïve Bayes, Multilayer Perceptron for predicting disease using WEKA tool. This is including size of image dataset, preprocessing, segmentation techniques, types of classifiers.

CHAPTER 2

OBJECTIVES

In this work, an automated smart irrigation system along with plant disease detection using IOT.Disease detection is through machine learning. Image processing for disease detection of visually seen symptoms of plant.Using Weka tool the treatment is suggested to reduce the damage levels.

CHAPTER 3

LITERATURE SURVEY

3.1 A Low Cost Smart Irrigation Control System

This paper focus on a smart irrigation system which is cost effective and a middle class farmer use it in farm field. Today we are living in 21st century where automation is playing important role in human life. Automation allows us to control appliances automatic control. It not only provide comfort but also reduce energy, efficiency and time saving. Today industries are use automation and control machine which is high in cost and not suitable for using in a farm field. So here we also design a smart irrigation technology in low cost which is usable by Indian farmers. The objectives of this paper were to control the water motor automatically and select the direction of the flow of water in pipe with the help of soil moisture sensor. Finally send the information(operation of the motor and direction of water) of the farm field to the mobile message and g-mail account of the user.
In our country Agriculture is major source of food production to the growing demand of human population. In agriculture, irrigation is an essential process that influences crop production. Generally farmers visit their agriculture fields periodically to check soil moisture level and based on requirement water is pumped by motors to irrigate respective fields. Farmer need to wait for certain period before switching off motor so that water is allowed to flow in sufficient quantity in respective fields.[1] This irrigation method takes lot of time and effort particularly when a farmer need to irrigate multiple agriculture fields distributed in different geographical areas. Traditionally farmers will present in their fields to do irrigation process. But nowadays farmers need to manage their agricultural activity along with other occupations. Automation in irrigation system makes farmer work much easier.
Sensor based automated irrigation system provides promising solution to farmers where presence of farmer in field is not compulsory. A small processor programmed for control

a electromagnetic valve and also compare to electromagnetic valve operate motor to start watering. Really INDIAN farmers need cheap and simple user interface for controlling sensor based automated irrigation system. Now a day's internet is widely used. Using internet farmer know about the agriculture field irrigation status. This helps farmers to know the status of farm field watering direction through a message whether the farmer is far away from field know the status of water motor is ON or OFF and direction of watering.

3.2 Automatic Crop Irrigation System

In most country's economy, agriculture has been playing a vital role. Agriculture is the basis of livelihood for the population through the production of food and important raw materials. Moreover, agriculture continues to play an important role in providing large scale employment to the people . In general, most of the farmers use manual system to water their crops in the farm, this system is inefficient. There are many advantages in developing microcontroller based circuits and incorporating new sensor technologies into agricultural applications . At present, labor-saving and watersaving technology is a key issue in irrigation . The proposed system has been started with a goal to automate irrigation process and make the best use of technologies for farmers. If we water manually, the possibility to over watering is high. Some crops can drown when we supply too much water to them. In order to overcome this problem, automatic watering system is used. Some sensors such as temperature sensor and humidity detector are used to control the watering system. The system also has the capability to indicate the water level. Farm automation includes monitoring humidity, temperature, water level of wells and uniform supply of water using water sprinkler and drip water irrigation. This includes automated supply of water to the farm fields according to the crops sown and the depth of indicator strip. Farm automation will definitely prove to be a boon in the countryside where frequent power failures occur and ensuring continuity of water supply or storage is a cumbersome task.[2] The proposed system is mainly works with the idea of automating the irrigation process and make it farmer friendly. It senses temperature,humidity, water storage levels and on top of it all, it keeps the farmer updated with regular alerts send through SMSs. A SIM 900 Module is used to send the messages on the registered cellular phone number. Such alert nullifies the need of constant supervision and thus buying time for the farmer for extra work apart from irrigation. This system is useful for the farmers who have plenty of farm area, and the farmers who travel more and cannot give proper attention to their farms, as irrigation demands constant supervision.

3.3 New Optimized Spectral Indices for Identifying and Monitoring Winter Wheat Diseases

The vegetation indices from hyperspectral data have been shown to be effective for indirect monitoring of plant diseases. However, a limitation of these indices is that they cannot distinguish different diseases on crops. We aimed to develop new spectral indices (NSIs) that would be useful for identifying different diseases on crops. Three different pests (powdery mildew, yellow rust, and aphids) in winter wheat were used in this study. The new optimized spectral indices were derived from a weighted combination of a single band and a normalized wavelength difference of two bands. The most and least relevant wavelengths for different diseases were first extracted from leaf spectral data using the RELIEF-F algorithm.[3] Reflectance of a single band extracted from the most relevant wavelengths and the normalized wavelength difference from all possible combinations of the most and least relevant wavelengths were used to form the optimized spectral indices. The classification accuracies of these new indices for healthy leaves and leaves infected with powdery mildew, yellow rust, and aphids were 86.5respectively. We also applied these NSIs for nonimaging canopy data of winter wheat, and the classification results of different diseases were promising. For the leaf scale, the powdery mildew-index (PMI) correlated well with the disease index (DI), supporting the use of the PMI to invert the severity of powdery mildew. For the canopy scale, the detection of the severity of yellow rust using the yellow rust-index (YRI) showed a high coefficient of determination between the estimated DI and its observations, suggesting that the NSIs may improve disease detection in precision agriculture application.

3.4 Image Processing for Smart Farming:Detection of Disease and Fruit Grading

Due to the increasing demand in the agricultural industry, the need to effectively grow a plant and increase its yield is very important. In order to do so, it is important to monitor the plant during its growth period, as well as, at the time of harvest. In this paper image processing is used as a tool to monitor the diseases on fruits during farming, right from plantation to harvesting. For this purpose artificial neural network concept is used. Three diseases of grapes and two of apple have been selected. The system uses two image databases, one for training of already stored disease images and the other for implementation of query images. Back propagation concept is used for weight adjustment of training database. The images are classified and mapped to their respective disease categories on basis of three feature vectors, namely, color, texture and morphology. From these feature vectors morphology gives 90 percentage correct result and it is more than other two feature vectors. This paper demonstrates effective algorithms for spread of disease and mango counting. Practical implementation of neural networks has been done using MATLAB[4].

3.5 IoT based Smart Irrigation and Plant Disease Detection

The agricultural sector is the biggest user of water, followed by the domestic sector and the industrial sector. Groundwater contributes to around 65percent of the country's total water demand and plays an important role in shaping the nation's economic and social development. The requirement of building an automation system for an office or home is increasing day-by day. Automation makes an efficient use of the electricity and water and reduces much of the wastage. The need of automated irrigation system is to overcome over irrigation and under irrigation. Over irrigation occurs because of poor distribution or management of waste water, chemical which leads to water pollution. Under irrigation leads to increased soil salinity with consequent buildup of toxic salts on the soil surface in areas with high evaporation. Another problem faced is plant diseases during growth, due to the unpredictable climatic changes, there is lack of nutrients and minerals to the crops. This leads to deficiency diseases which in turn affects the crop productivity. Plants get affected not only due to deficiency but also caused due to micro-organisms like fungi, bacteria, virus and mites[5]. This kind of borne diseases are very dangerous as they affect large farming. And so, it is very important to take steps for maintaining the crops. Manual observation over the health of the crops might result in errors and may even be difficult in case of large acres of land. Generally, whenever there is disease to a plant, we can say that leaves are the main indicator of the disease caused to the plant. Mostly we can see the spots on the leaves of it due to disease. However, when the amount of disease to the plant is large then the whole leaf gets covered by the disease spots. With the help of sensors and GSM shield, controlled by Raspberry Pi 3 microcomputer, we designed a system to automatically sprinkle accurate amount of water by detecting soil moisture, daylight intensity, water level and warn the administrator about intruder or plant disease through SMS or Email. In a Smart Irrigation System, the Raspberry pi is combined with Cloud Computing to provide the communication between the person and the system. Cloud is a service provider or a type of internet-based computing that provides shared computers processing resource and other devices on demand.

3.6 Prediction of Leaf Diseases by using Machine Learning Techniques-A New Approach to Applied Informatics

Applied Informatics is a new emerging field which encompasses information technology and other areas of science. Many Automatic detection of a plant disease is proving their benefits in more fields of plant leaves. Proposed work focus on using machine learning techniques with multilayer Perceptron and simple K-Means algorithm for predicting sugarcane leaf disease by using Weka tool and the obtained results are promising.
An Informatics is the information processing structure of natural scientific and engineered systems. It always interconnected the relevant information with the human intervention. The informatics systems developing their theoretical performance in different computer studies atmosphere. By this concept the Applied Informatics inattentive on many speculative approaches with assorted application fields. Applied Informatics spotlight to develop their multipart disciplines of research at extensive features in technical and technological, production and communal fields.The technology used in this paper is Machine Learning. The Machine Learning is a field from the computer science it processes the computers learning ability by explicit programming skills. This Machine Learning technique was evolved from the Artificial Intelligence concepts. To make some predictions in the data that is in a large set of information this machine learning technique will studies and constructs algorithms. To make decisions and predictions these algorithmic programming instructions overcomes statically by building input models. In this paper the machine learning technique is using Image Processing[6].
Hence Image Processing is processing the images with different form of mathematical functions and operations by some signal processing. It is usually refers to digital image processing to acquits the images for producing the input images. The digital image processing is used to perform the computational algorithms in digital images. The digital image processing allowing the wider range of algorithms for applying the input data and which can avoid the problems by building up of a noisy signal distortion during the processing. The digital image is a two dimensional image which has a values by pixels and pictures. So by this image processing similar sets of plant leaf diseases are identify from various plants. The plant leaf disease is a major problem arising now days in an agricultural field. It produces large number of diseases by some insects affecting their parts. It is very difficult to identify the infected areas from a leaves in a short time span. Also the manual calculations were not in a sufficient manner. Mostly it is difficult to identify the infected parts of a leaf by manually at a short time. To overcome this difficulties a major technical work is to be initiated to complete the work much faster and accurate. The image processing is taking place about this major problem by the help of machine learning tools. And in this paper the tool using here is WEKA tool.

3.7 Sugarcane Disease Detection Using Data Mining Techniques

Leaf diseases may lead to severe loss in agricultural yields. To improve agricultural yields the identification and classification of leaf disease is essential. The Sugarcane leaf diseases can be manually identified by the disease syndrome based on the experience. In this process, mostly a misguidance of plant leaf disease symptoms may be identified. Hence, in this paper we propose an accurate and automated process of leaf disease identification. The R Datasets are used to perform experimental study. Techniques like Multilayer perceptron (MLP), J48 pruned trees and clustering algorithm like k-means are used for predicting sugarcane leaf diseases by using Weka tool and shown its potential results.
Today, Data mining is growing rapidly in all domains namely Healthcare, Market Analysis, Financial Banking, Research Analysis and Agriculture, which represents knowledge implicitly stored in large data sets. current technologies provide us lot of information on agriculture related activities and also used to retrieve useful hidden information from them[7]. Generally various classification and clustering algorithms have been proposed in the past for analyzing the leaf diseases of various plants. Clustering is a process of grouping the data based on the characteristics of data. In common clustering techniques falls into unsupervised category for statistical data analysis used in many fields including machine learning, data mining, pattern recognition, image analysis and bioinformatics. reports that there is no best clustering technique because the success is fully depends on the type of data. Classification techniques falls into supervised category for predicting the target class for each case in the data.

3.8 LoRa based Smart Irrigation System

This paper proposes a smart irrigation system based on ESP32 TTGO LoRa. The system monitors different environmental factors like temperature, moisture, and the volume of water required by the crops, utilizing sensors i.e temperature, soil moisture, and water flow. The information is gathered and given to the ESP 32 TTGO placed in the farm which is connected to another ESP32 TTGO placed within the range of 5KM (range can be improved if an antenna with high gain is used) through LoRa protocol. This module is connected to IBM cloud through the internet using the WiFi stack present on ESP32 which demonstrates the continuous qualities. This enables the farmer or IBM Bluemix to control irrigation pumps and sprinklers from distant places and to meet the standard qualities which would assist the farmer with yielding better quantity and quality of the crop Agriculture is a field where water is required in more amount. Wastage of water is a real issue in agriculture. During the cultivation more amount of water is given to the fields. There are numerous methods to spare or to control wastage of water in agriculture . In the world, the majority of irrigation systems work manually[8]. These outdated techniques are supplanted with semiautomatic and automatic procedures . The accessible customary methods resemble drip irrigation, sprinkler system, ditch irrigation, terraced irrigation . The worldwide irrigation situation is classified by expanded interest for higher agricultural efficiency, poor execution and diminished accessibility of water for agriculture . These issues can be rectified if we make use of smart irrigation systems.Through Internet of Things, agriculture products will have a fresh growth state, better storage preservation, and best quality. With the advancement of Internet of things, its innovation has been broadly connected to all the aspects of agricultural.

CHAPTER 4

PROPOSED SYSTEM

4.1 Block Diagram

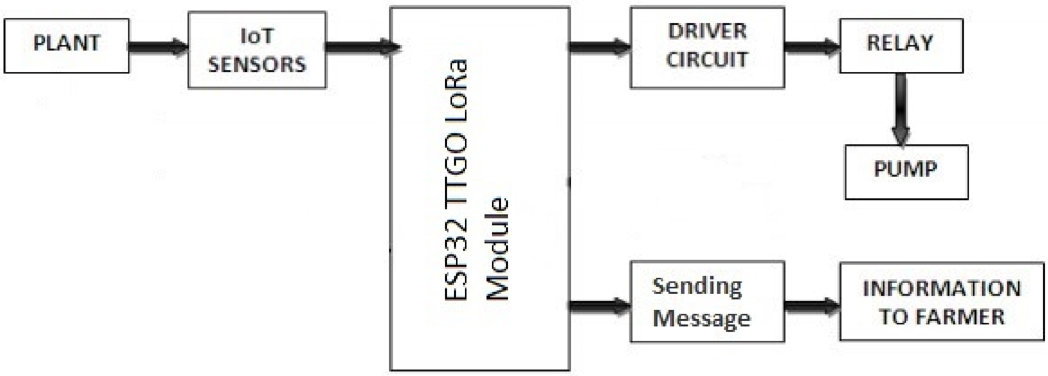

FIGURE 4.1: Block Diagram for irrigation

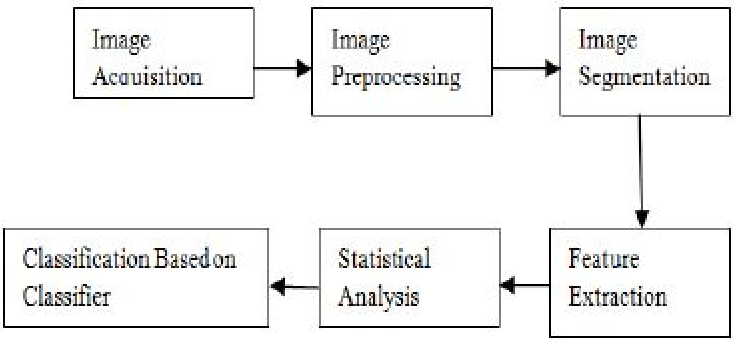

FIGURE 4.2: Block Diagram for Disease Detection

4.2 Irrigation

In this system, soil moisture sensor senses the moisture level of the soil. If soil will get dry then sensor senses low moisture level and automatically switches on the water pump to supply water to the plant.As plant get sufficient water and soil get wet then sensor senses enough moisture in soil. After which the water pump will automatically get stopped.

A smart irrigation system based on ESP32 TTGO LoRa. The system monitors different environmental factors like temperature, moisture, and the volume of water required by the crops, utilizing sensors i.e temperature, soil moisture, and water flow. The information is gathered and given to the ESP 32 TTGO placed in the farm which is connected to another ESP32 TTGO placed within the range of 5KM (range can be improved if an antenna with high gain is used) through LoRa protocol. This module is connected to IBM cloud through the internet using the WiFi stack present on ESP32 which demonstrates the continuous qualities. This enables the farmer or IBM Bluemix to control irrigation pumps and sprinklers from distant places and to meet the standard qualities which would assist the farmer with yielding better quantity and quality of the crop Agriculture is a field where water is required in more amount. Wastage of water is a real issue in agriculture. During the cultivation more amount of water is given to the fields. There are numerous methods to spare or to control wastage of water in agriculture In the world, the majority of irrigation systems work manually. These outdated techniques are supplanted with semiautomatic and automatic procedures . The accessible customary methods resemble drip irrigation, sprinkler system, ditch irrigation, terraced irrigation . The worldwide irrigation situation is classified by expanded interest for higher agricultural efficiency, poor execution and diminished accessibility of water for agriculture . These issues can be rectified if we make use of smart irrigation systems.
Smart irrigation is one such innovation which has pulled the attention of many researchers and is advancing . Smart irrigation is where water usage is limited and is more feasible economically, socially and conventionally. The thought and advancement of smart irrigation system is essentially centered around decreasing human efforts and lessens water usage and electricity utilization. The increasing demand for food because of population expansion put farmers to confront many issues with respect to the amount and nature of crops, which in fact brought another challenge on researchers to create and approach a keen irrigation system that would give farmers a smart instrument which helps them in yielding a quality crop. Even though smart irrigation has developed, yet so far no solution is acquired to measure the precise flow of water. Hence our prime move all through the project work has been to outline an irrigation system which furnishes all

the above highlights alongside ordinary highlights accessible in a keen water system, for example, estimating dampness profile of the field, the goal to keep crops from waterlogging issues, temperature detecting because crops are sensitive to temperature too. The parameters are calculated using various sensors.

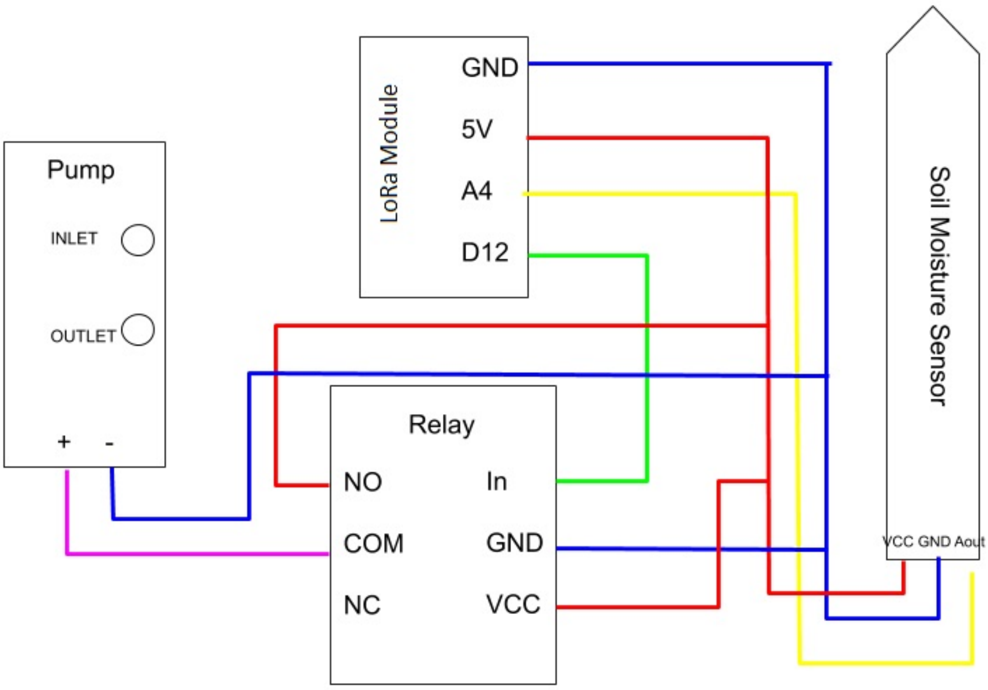

Figure 4.3: Schematic Diagram

4.3 Components

4.3.1 LoRa Module

The device has an SX1276 chip based on the ESP32 core. The device has an onboard OLED display, LoRa, WiFi and Bluetooth stacks. The device is operated at 865MHz with high transmission range and it is more reliable. It has a sensitivity over 148dBm and an output power of +20dBm. The ESP32 TTGO LoRa board is programmed using Arduino IDE. The required libraries can be downloaded from Github. To connect the board to the Windows, Linux or OSX systems, CP2102 USB to UART bridge should be installed on the system which is provided by the Silicon Labs.
LoRa (Long Range) is a proprietary low-power wide-area network modulation technique. It is based on spread spectrum modulation techniques derived from chirp spread spectrum (CSS) technology. It was developed by Cycleo of Grenoble, France and acquired by Semtech, the founding member of the LoRa Alliance and it is patented.

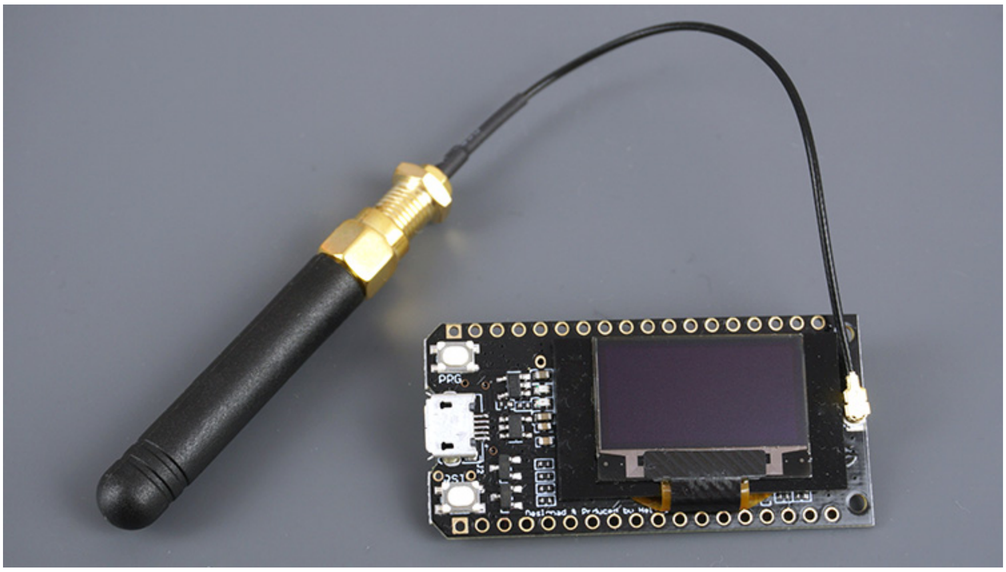

FIGURE 4.4: ESP32 TTGO LoRa Module

4.3.2 Moisture Sensor

The soil moisture sensor consists of two leads that are used to measure volume of water content in soil. These leads allow the current to pass through the soil and in return calculates the resistance value to measure the moisture level. If there is more water in soil then soil will conduct more electricity, means less resistance value along with high level of moisture. In the same manner if there is less water in soil then soil will conduct less electricity, means high resistance value along with low level of moisture.

FIGURE 4.5: Moisture sensor

4.3.3 Humidity Sensor(DHT11)

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). Its fairly simple to use, but requires careful timing to grab data. You can get new data from it once every 2 seconds, so when using the library from Adafruit, sensor readings can be up to 2 seconds old. Comes with a 4.7K or 10K resistor, which you will want to use as a pullup from the data pin to VCC.

Specifications:

3 to 5V power and I/O
2.5mA max current use during conversion (while requesting data)
Good for 20-80 percent humidity readings with 5 percent accuracy
Good for 0-50 °C temperature readings +-2 °C accuracy
No more than 1 Hz sampling rate (once every second)
Body size 15.5mm x 12mm x 5.5mm 4 pins with 0.1” spacing
Adafruit Learning Documentation for DHTxx Sensors
RoHS compliant.

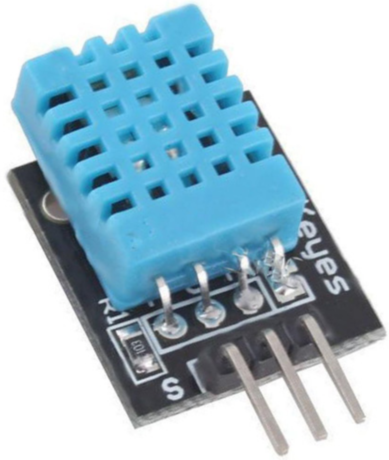

FIGURE 4.6: DHT11

4.3.4 Relay

The connections between the relay module and the Arduino are really simple: GND: goes to ground. IN1: controls the first relay (it will be connected to an Arduino digital pin) IN2: controls the second relay (it should be connected to an Arduino digital pin if you are using this second relay.

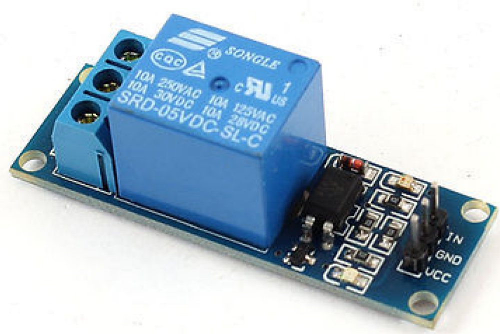

FIGURE 4.7: Relay

4.3.5 PC

IoT devices include wireless sensors, software, actuators, and computer devices. They are attached to a particular object that operates through the internet, enabling the transfer of data among objects or people automatically without human intervention.
A computer is a machine that can be programmed to carry out sequences of arithmetic or logical operations automatically. Modern computers can perform generic sets of operations known as programs. These programs enable computers to perform a wide range of tasks. A computer system is a "complete" computer that includes the hardware, operating system (main software), and peripheral equipment needed and used for "full" operation. This term may also refer to a group of computers that are linked and function together, such as a computer network or computer cluster.

Figure 4.8: PC

4.3.6 Smart Phone

A smartphone is a portable device that combines mobile telephone and computing functions into one unit. They are distinguished from feature phones by their stronger hardware capabilities and extensive mobile operating systems, which facilitate wider software, internet (including web browsing over mobile broadband), and multimedia functionality (including music, video, cameras, and gaming), alongside core phone functions such as voice calls and text messaging. Smartphones typically contain a number of metal–oxide–semiconductor (MOS) integrated circuit (IC) chips, include various sensors that can be leveraged by pre-included and third-party software (such as a magnetometer, proximity sensors, barometer, gyroscope, accelerometer and more), and support wireless communications protocols (such as Bluetooth, Wi-Fi, or satellite navigation).

FIGURE 4.9: Smart Phone

4.4 Disease Detection

Disease detection from the images of the plant leaf, fruit is one of the interesting research areas in agriculture field. This field needs a reliable prediction methodology to detect factors influencing disease. Machine learning is the process of analyzing data from different aspects and summarizing it into valuable information. It allows users to analyze data from different dimensions, categorize and the relationships are identified. WEKA is a data analysis tool for machine learning classification. Machine learning classification is a vital technique with more applications in various fields. It is used to classify each item in a set of data into one of predefined set of classes. In this paper present a different image processing and machine-learning techniques used for the identification of plant diseases based on images of disease infected plants. The proposed work focus on machine learning techniques with Naïve Bayes, Decision tree, simple K-Means, Multilayer Perceptron, SVM, Random forest algorithm for predicting disease using WEKA tool. This is including size of image dataset, preprocessing, segmentation techniques, types of classifiers.

Indian economy is dependent on agriculture, now a days the productivity of plants, crops is normally affected by the diseases. In plants, most of the leaves, fruits are affected by fungi, bacteria, and viruses. It is very difficult to identify the infected areas in a short period. To overcome this difficulty a major technical work is to be initiated to complete the work faster and accurate. The image processing is taking place about this major problem by the help of machine learning using WEKA tool. It is needed to use novel techniques to increase the productivity of agriculture products and also financial income of farmers. Machine learning technique is a process of discovering pattern of data. The patterns are discovered must be meaningful in that they lead to some merits. The overall aim of the machine learning process is to extract information from a data set and transform it into a useful data in order to aid user decision making. It is used in many applications like banking, agricultural and Health bio-informatics. Analysis of Different Classification Techniques Using machine learning for a challenging task in agricultural research area. It is very tough to find out the best classification algorithms for comparing in different algorithms in various datasets. Our dissertation concerns with which algorithm, is capable to diagnose plant disease data accurately as well as quickly. For this purpose to perform a better approach, this problem of agricultural plant data comments into two classes: Data Collection, Classification algorithm.

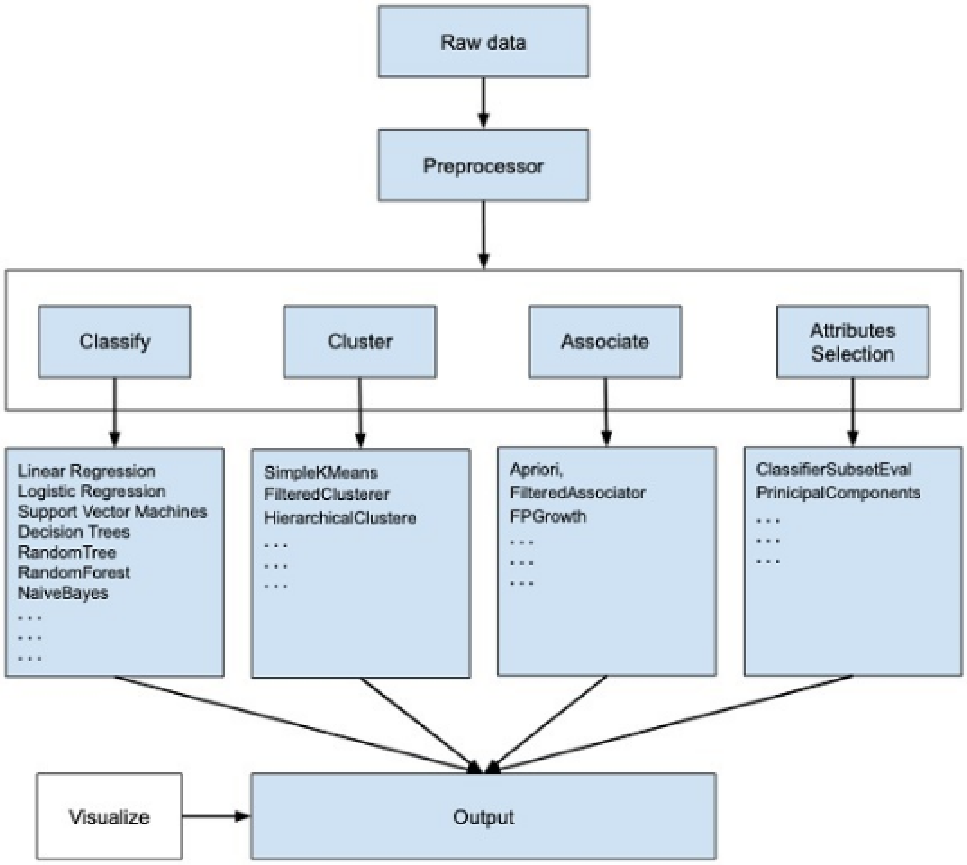

Figure 4.10: About Weka

4.5 Weka Tool

the major defects of a plant disease will be rectified by the different machine learning techniques. So for the studies have been concerned here the technology which is introducing is WEKA tool. Algorithms can be applied either directly or to a dataset called from own java code. WEKA implements algorithms for data preprocessing, classification, regression, clustering and association rules; it also includes visualization tools . An understanding of algorithms is combined with detailed knowledge of the datasets. Data sets in WEKA are validation, training and test set. Learning methods in WEKA are called classifiers which contain tunable parameters that can be accessed through a property object editor. Portability, since it is fully implemented in the Java programming language and thus runs on almost any new computing platform. It is to improving the quality of data, the continuous attributes in discretely requiring data mining. It is for the finite set of intervals to generate distinct values. A comprehensive collection of data preprocessing and modeling techniques, ease of use due to its graphical user interfaces. Features:

- 49 data preprocessing tools
- 76 classification/regression algorithms
- 8 clustering algorithms
- 3 algorithms for finding association rules
- 15 attribute/subset evaluators + 10 search
- algorithms for feature selection

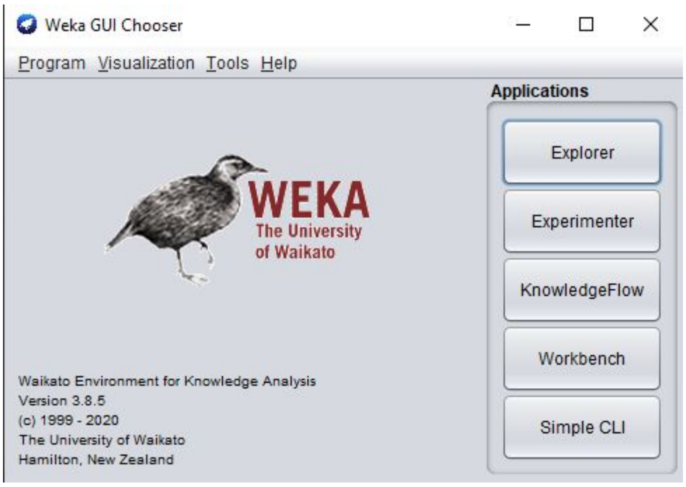

FIGURE 4.11: Weka Tool

4.5.1 Preprocessor

Preprocessor is used to clean the noisy data. If data is noisy we can't do further steps for analysis. So first we find what are the problems occurring in our data, ABT (Analyze Base Table) in our data we can view from the excel file, and use some excel filter menus to find details of the datas. Data preprocessing is divided into four stages: data cleaning, data integration, data reduction, and data transformation.

4.5.2 Classify

After preprocessing the data we can use that data to find some information by following the algorithms.systematic arrangement in groups or categories according to established criteria specifically. 7 Types of Classification Algorithms

Logistic Regression.
Naïve Bayes.
Stochastic Gradient Descent.
K-Nearest Neighbours.

Decision Tree.
Random Forest.
Support Vector Machine.

4.5.3 Logistic Regression

Logistic regression is a linear classification method that learns the probability of a sample belonging to a certain class. Logistic regression tries to find the optimal decision boundary that best separates the classes. it represents True or false or yes or No category algorithms. Loot at the below image it shows two way of separation like that out data also has two way of separation.

4.5.4 Naive Bayes

Naive Bayes implements the probabilistic Naïve Bayes classifier. Naïve Bayes Simple uses the normal distribution to model numeric attributes. This can use kernel density estimators, which improve performance if the normality assumption if grossly correct; it can also handle numeric attributes using supervised discretization. Naïve Bayes updateable is an incremental version that processes one request at a time. It can use a kernel estimator but not discretization.

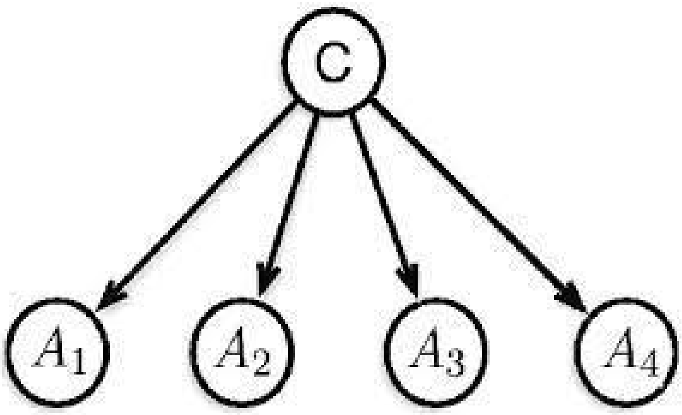

FIGURE 4.12: Architecture of Nive Bayes

4.5.5 Stochastic Gradient Descent

Stochastic gradient descent is an iterative method for optimizing an objective function with suitable smoothness properties. It can be regarded as a stochastic approximation of gradient descent optimization, since it replaces the actual gradient by an estimate thereof. Look at the following image: rice become rice flour and then it get some optimizing , yes still some of irrelevant things are mixed with it .

4.5.6 K-Nearest Neighbours

kNN stands for k-Nearest Neighbours. It is a supervised learning algorithm. This means that we train it under supervision.

4.5.7 Decision Tree

Decision Tree is a Supervised learning technique that can be used for both classification and Regression problems, but mostly it is preferred for solving Classification problems. It is a tree-structured classifier, where internal nodes represent the features of a dataset, branches represent the decision rules and each leaf node represents the outcome.

4.5.8 Random Forest

Random forest is a supervised learning algorithm. The “forest” it builds is an ensemble of decision trees, usually trained with the “bagging” method. The general idea of the bagging method is that a combination of learning models increases the overall result.

4.5.9 Support Vector Machine

Support Vector Machine” (SVM) is a supervised machine learning algorithm which can be used for both classification or regression challenges. ... The SVM classifier is a frontier which best segregates the two classes (hyper-plane/ line).

4.5.10 Cluster

WEKA supports several clustering algorithms such as EM, FilteredClusterer, HierarchicalClusterer, SimpleKMeans and so on. You should understand these algorithms completely to fully exploit the WEKA capabilities. As in the case of classification, WEKA allows you to visualize the detected clusters graphically.

4.5.11 Associate

Rules can predict any attribute, or indeed any combination of attributes. To find them we need a different kind of algorithm. “Support” and “confidence” are two measures of a rule that are used to evaluate them and rank them. The most popular association rule learner, and the one used in Weka, is called Apriori.

4.5.12 Attribute Selection

Attribute selection means that if we find the rice type, we measure some parameters rice size, rice colour, rice length, rice width. These measurements help us to find that type. The same thing weka tool also supports attribute selection via information gain using the InfoGainAttributeEval Attribute Evaluator. Like the correlation technique above, the Ranker Search Method must be used.

4.5.13 Multilayer Perceptron

The Multilayer Perceptron (MLP) which is also called as Feed Forward Artificial Neural Network. It consists of appropriate nodes by directed graphs; here every node is connected to a node. The node is a neuron with nonlinear functions. To training a network which uses the back propagation algorithms also it is not linearly separable. A weighted inputs will map the each neurons output. Any number of layers can be reduced to a two-layer input and output model.
It is referred to as “vanilla “neural networks, hence it has a single hidden layer. In all the neurons a multilayer Perceptron has a linear activation function. A weighted inputs will maps the each neurons output. Any number of layers is proving with the standard algebra by the two-layer input and output model. A nonlinear activation function is develop the frequency of potential actions of biological neurons in the brain will make a multilayer Perceptron in different manner .

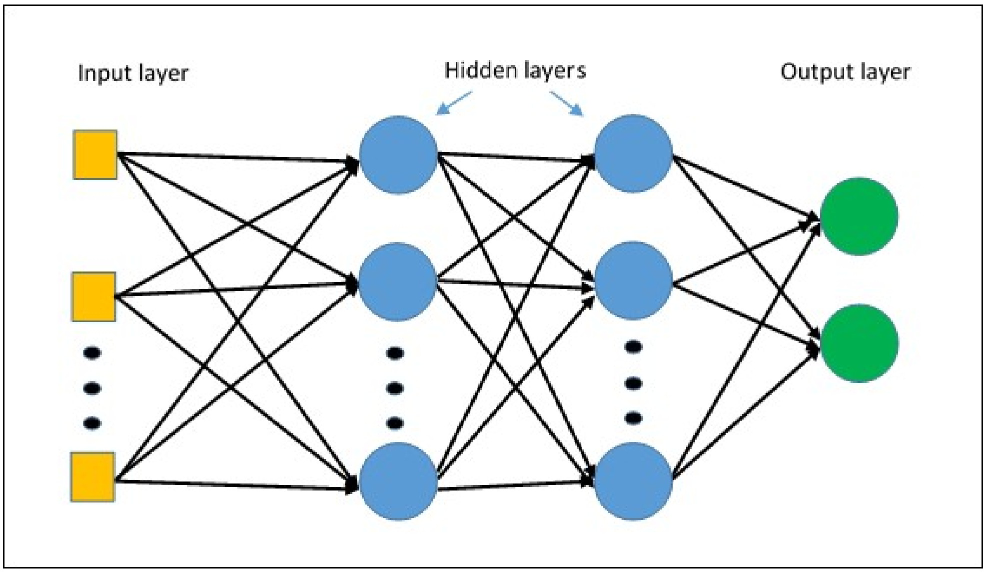

FIGURE 4.13: Architecture of Multilayer Perceptron

4.6 Dataset

Here we use soyabean leaf to detect the disease.The dataset of soyabean consist of 683 instances ,30 attributes and 19 classes. The processed data in Weka can be analyzed using different data mining techniques like, Classification, Clustering, Association rule mining, Visualization etc. algorithms. The information can be extracted with respect to two or more associative relation of data set. Here we use two data mining algorithms .They are Naive bayer's and Multilayer perceptron algorithms.

Attributes:

1.Date

2.Plant Stand

3.temp

4.Hail

5.Crop Shift

6.Area Damaged

7.Seed tmt

8.Germination

9.Plant Growth

10.Leaf Spots Halo

11.Leaf Spot Marg

12.Leaf Spot Size

13.Leaf Shread

14.Leaf Mild

15.Stem

16.Lodging

17.Stem Cankers

18.Canker Lesion

19.Fruiting Bodies

20.External Decay

21.Mycellium

22.Fruit Pods

23.Fruit Spot

24.Seed Mold Growth

25.Seed Discolor

26.Seed Size

27.Shrivelling

28.Roots

29.Leaves

30.Class

Class:

1.diaporthe-stem-canker

2.charcoal-rot

3.rhizoctonia-root-rot

4.phytophthora-rot

5.brown-stem-rot

6.powdery-mildew

7.downy-mildew

8.brown-spot

9.bacterial-blight

10.bacterial-pustule

11.purple-seed-stain

12.anthracnose

13.phyllosticta-leaf-spot

14.alternarialeaf-spot

15.frog-eye-leaf-spot

16.diaporthe-pod-and-stem-blight

17.cyst-nematode

18.2-4-d-injury

19.herbicide-injury

CHAPTER 5

IMPLEMENTATION

5.1 Irrigation

5.1.1 Coding

```
// if the soil is dryer than this number, then start watering
const int dry = 270;

const int pumpPin = 12;
const int soilSensor = A4;

void setup() {
  pinMode(pumpPin, OUTPUT);
  pinMode(soilSensor, INPUT);
  Serial.begin(9600);
  digitalWrite(pumpPin, HIGH);
  delay(5000);
}

void loop() {
  // read current moisture
  int moisture = analogRead(soilSensor);
  Serial.println(moisture);
  delay(5000);

  if (moisture >= dry) {
    // the soil is too dry, water!
    Serial.println("Watering starts now..moisture is " + String(moisture));
    digitalWrite(pumpPin, LOW);

    // keep watering for 5 sec
    delay(5000);

    // turn off water
    digitalWrite(pumpPin, HIGH);
    Serial.println("Done watering.");
```

```
  } else {
    Serial.println("Moisture is adequate.
    No watering needed " + String(moisture));
  }
}
```

```
# python.6

import random

from paho.mqtt import client as mqtt_client
import json
from twilio.rest import Client
account_sid = "AC30077e81a520f3c67d0a2593e0bdd970"
auth_token = "799c80360307090983650a2826ca6544"
client1 = Client(account_sid, auth_token)

broker = 'pubsub.icfoss.org'
port = 1883
topic = "d5a0e99f02db7822"
# generate client ID with pub prefix randomly
client_id = f'pubsub-mqtt-{random.randint(0, 100)}'
username = 'd5a0e99f02db7822'
password = 'ICFOSS::102-Irrigation_Irrigation'


def connect_mqtt() -> mqtt_client:
    def on_connect(client, userdata, flags, rc):
        if rc == 0:
            print("Connected to MQTT Broker!")
        else:
            print("Failed to connect, return code %d\n", rc)

    client = mqtt_client.Client(client_id)
    client.username_pw_set(username, password)
    client.on_connect = on_connect
    client.connect(broker, port)
    return client


def subscribe(client: mqtt_client):
    global client1
    def on_message(client, userdata, msg):
        print(f"Received `{msg.payload.decode()}` from `{msg.topic}` topic")
        data=msg.payload.decode()
        data= json.loads(data)
        print(data["payload"]["moisture"])
        if int(data["payload"]["moisture"]) <99:
            print("watering needed")
            client1.messages.create(from_=
            "+16786169966", body="watering needed", to="+919061414763")
        else:
            print("waterting not needed")

    client.subscribe(topic)
```

```
    client.on_message = on_message


def run():
    client = connect_mqtt()
    subscribe(client)
    client.loop_forever()


if _name_ == '_main_':
    run()
```

5.2 Disease Detection

5.2.1 Parameters Evaluations

i) Mean Absolute Error: The mean absolute error (MAE) is a quantity used to measure predictions of the absolute errors. MAE is given by
MAE = SAE / N
Where SAE= the sum of the absolute errors
N= the number of non-missing data points
ii) Root Mean Squared Error: It is the square root of the mean of the squares of the values. It squares the errors before they are averaged and RMSE gives a relatively high weight to large errors.
iii) TP-Rate: It is known as true positive rate and is calculated as
TP-Rate= TP/ (TP+FN)
iii) TN-Rate: It is known as true negative rate and is calculated as
TN-Rate= TN/ (TN+FP)
iv) FP-Rate: It is known as false positive rate and is calculated as
FP-Rate= FP/ (FP+TN)
v) FN-Rate: It is known as false negative rate and is calculated as
FN-Rate= 1-TP-Rate
vi) PRECISION = TP/ (TP+FP)
vii) RECALL= TP/ (TP+FN)
viii) ROC: Receiver Operating Characteristic Curve is a graphical plot equating the tp-rates and the fp- rates of a classifier as the refinement threshold of the classifier is different.

5.2.2 Algorithm for Disease Detection

initialize network weights (often small random values)

do

forEach training example named ex

prediction = neural-net-output(network, ex) // forward pass

actual = teacher-output(ex)

compute error (prediction - actual) at the output units

compute displaystyle Delta wh for all weights from hidden layer to output layer

compute displaystyle Delta wi for all weights from input layer to hidden layer // backward pass continued

update network weights // input layer not modified by error estimate

until all examples classified correctly or another stopping criterion satisfied

return the network

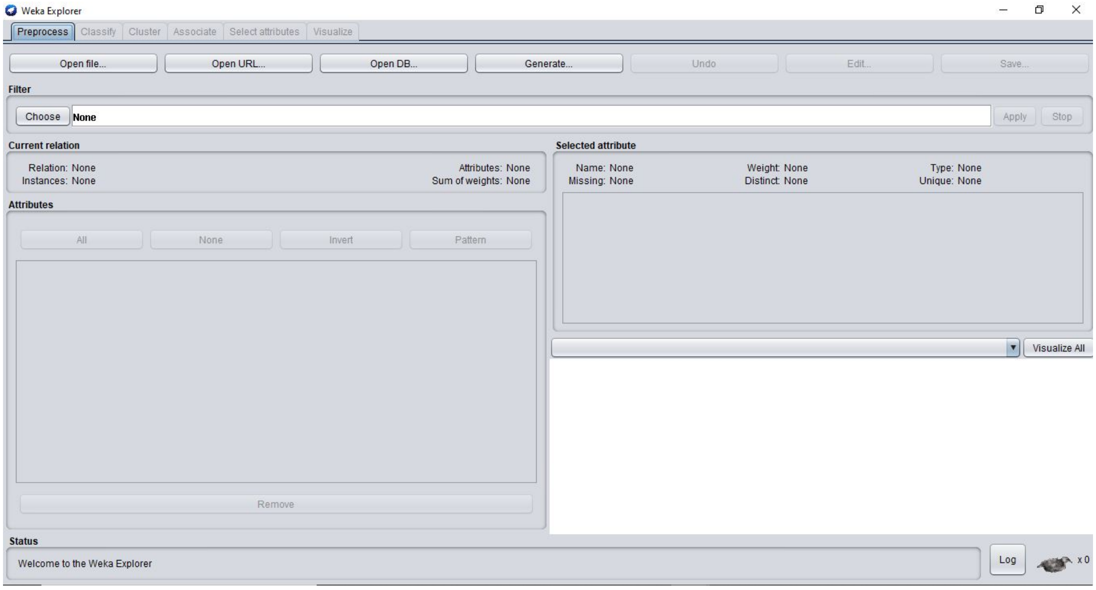

FIGURE 5.1: Window 1

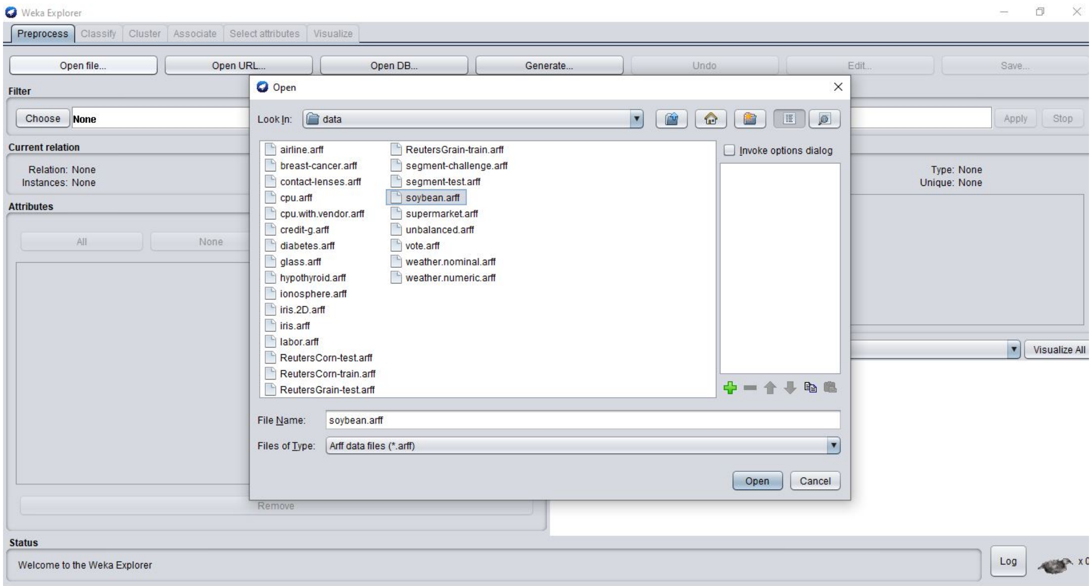

FIGURE 5.2: Window 2

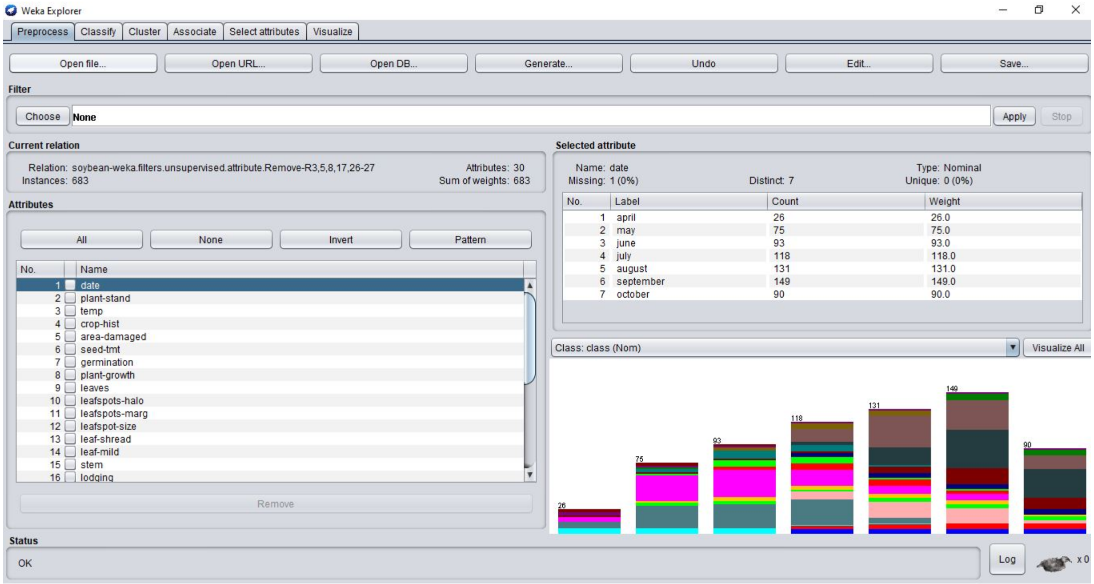

FIGURE 5.3: Window 3

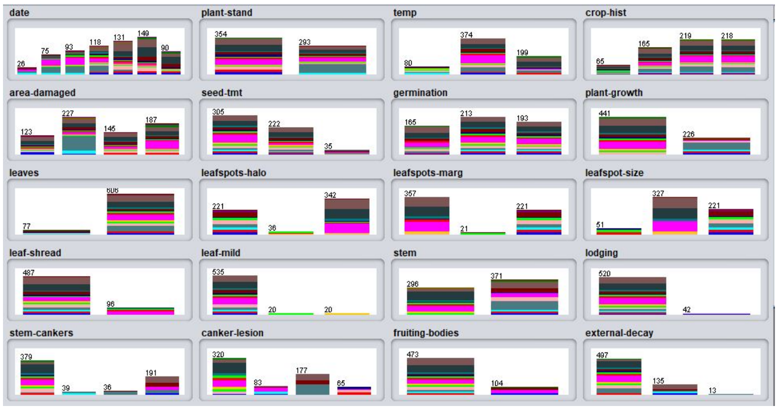

FIGURE 5.4: Window 4

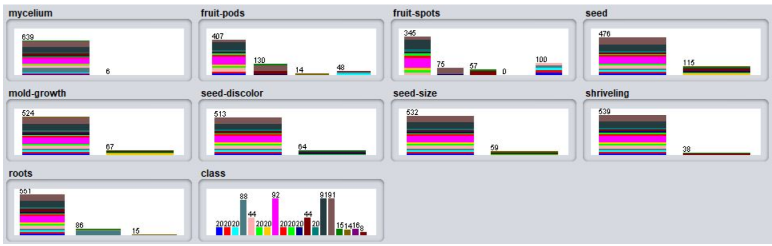

FIGURE 5.5: Window 5

5.2.3 Threshold Value Graph

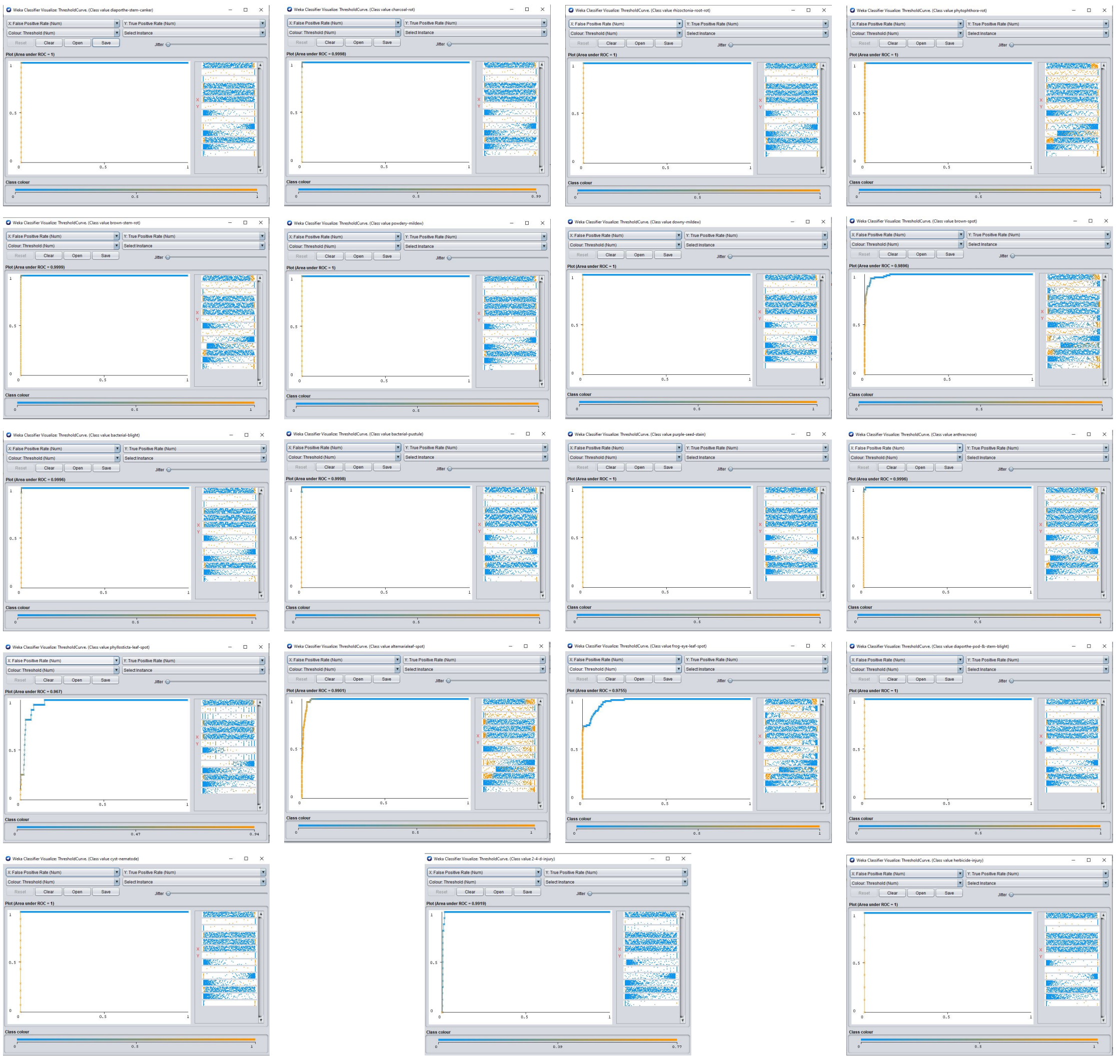

FIGURE 5.6: Naive Bayes Graph

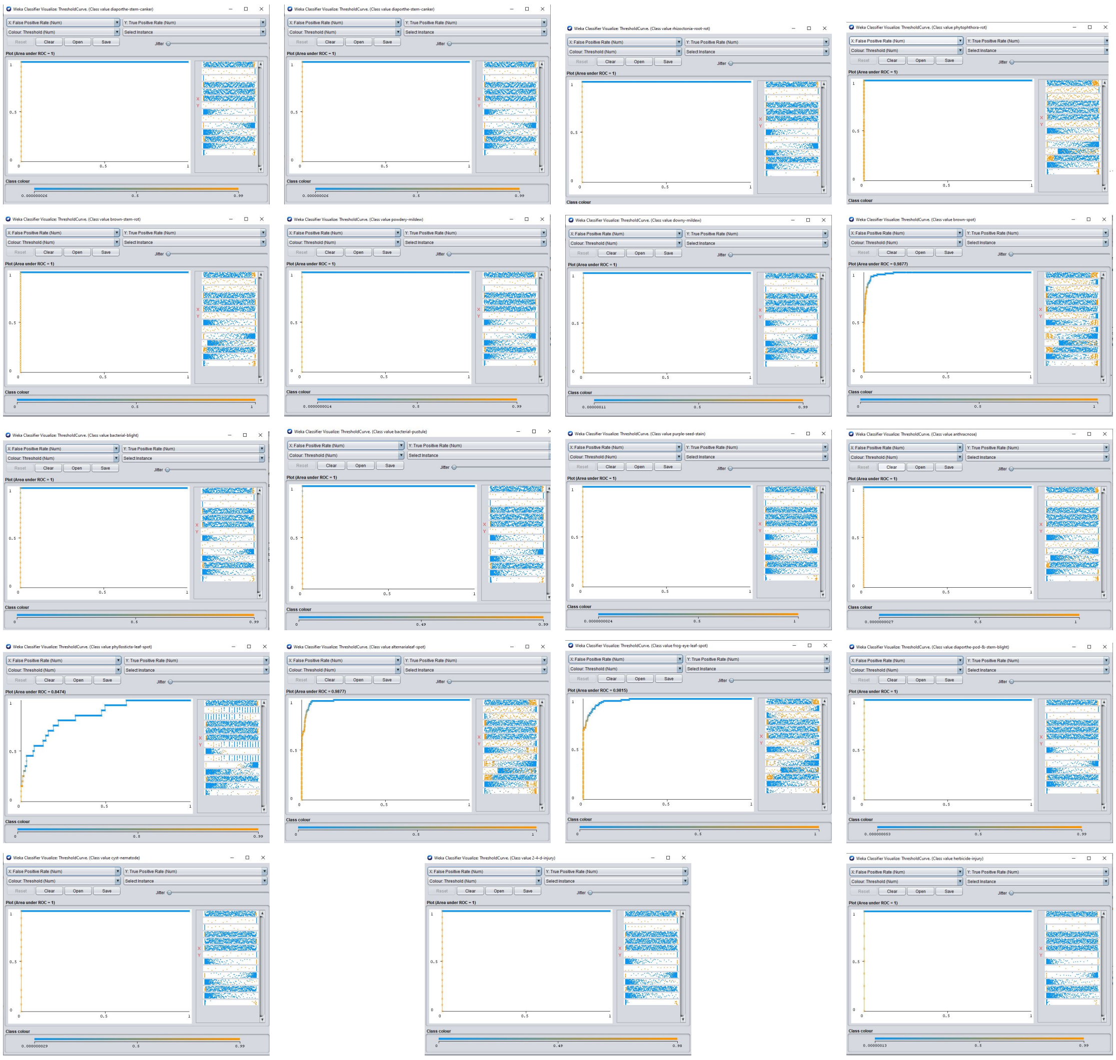

FIGURE 5.7: Multilayer Perceptron Graph

CHAPTER 6

OUTPUT

6.1 Irrigation

6.1.1 Serial Monitor

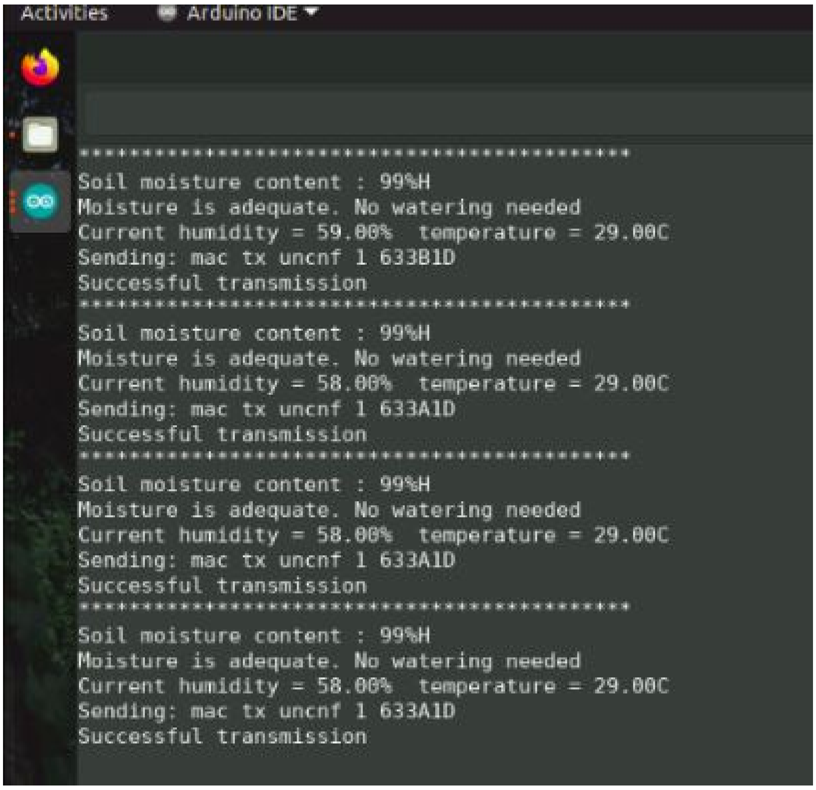

FIGURE 6.1: Serial Monitor

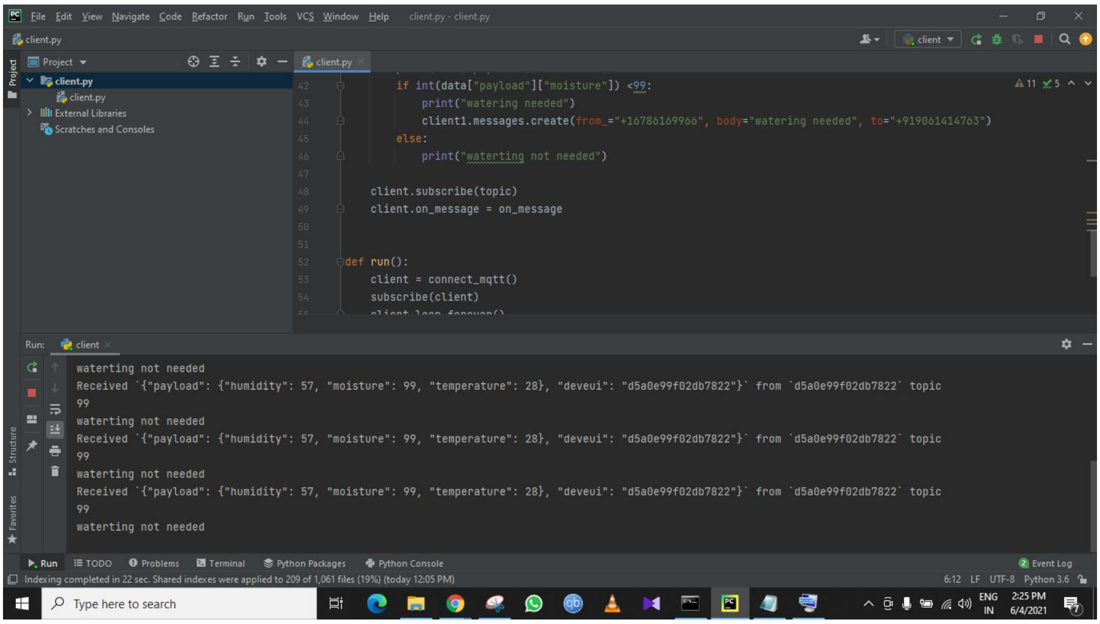

FIGURE 6.2: Output Window

6.2 Disease Detection

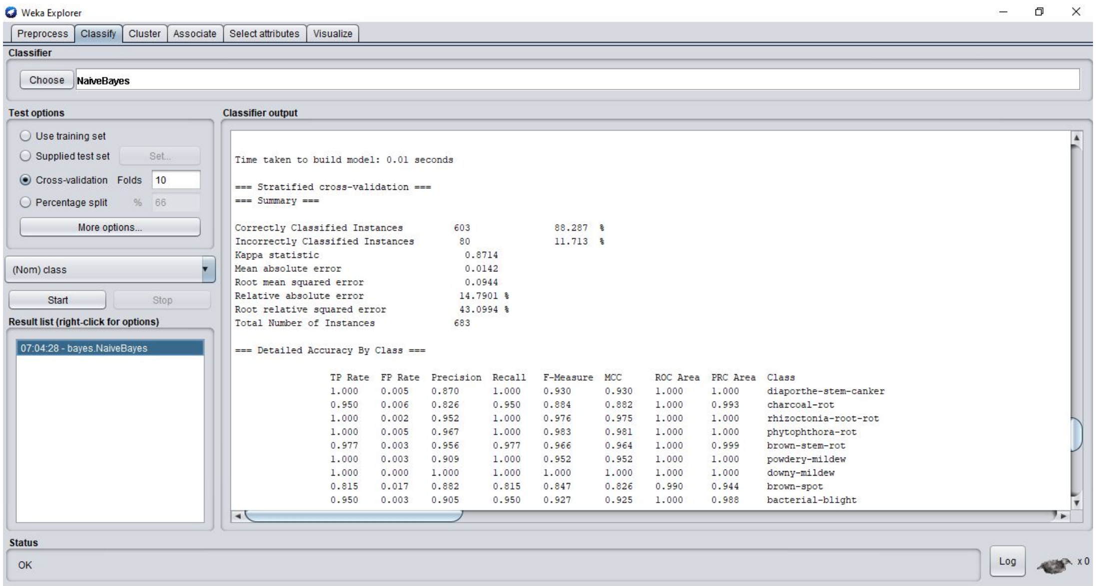

FIGURE 6.3: Naive Bayes

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	1.000	0.005	0.870	1.000	0.930	0.930	1.000	1.000	diaporthe-stem-canker
	0.950	0.006	0.826	0.950	0.884	0.882	1.000	0.993	charcoal-rot
	1.000	0.002	0.952	1.000	0.976	0.975	1.000	1.000	rhizoctonia-root-rot
	1.000	0.005	0.967	1.000	0.983	0.981	1.000	1.000	phytophthora-rot
	0.977	0.003	0.956	0.977	0.966	0.964	1.000	0.999	brown-stem-rot
	1.000	0.003	0.909	1.000	0.952	0.952	1.000	1.000	powdery-mildew
	1.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	downy-mildew
	0.815	0.017	0.882	0.815	0.847	0.826	0.990	0.944	brown-spot
	0.950	0.003	0.905	0.950	0.927	0.925	1.000	0.988	bacterial-blight
	0.900	0.000	1.000	0.900	0.947	0.947	1.000	0.993	bacterial-pustule
	1.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	purple-seed-stain
	0.955	0.003	0.955	0.955	0.955	0.951	1.000	0.995	anthracnose
	0.250	0.018	0.294	0.250	0.270	0.251	0.967	0.426	phyllosticta-leaf-spot
	0.989	0.056	0.732	0.989	0.841	0.825	0.990	0.930	alternarialeaf-spot
	0.714	0.007	0.942	0.714	0.813	0.798	0.976	0.895	frog-eye-leaf-spot
	1.000	0.001	0.938	1.000	0.968	0.968	1.000	1.000	diaporthe-pod-&-stem-blight
	1.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	cyst-nematode
	0.125	0.001	0.667	0.125	0.211	0.282	0.992	0.574	2-4-d-injury
	1.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	herbicide-injury
Weighted Avg.	0.883	0.013	0.885	0.883	0.874	0.868	0.993	0.941	

=== Confusion Matrix ===

FIGURE 6.4: Naive Bayes Table

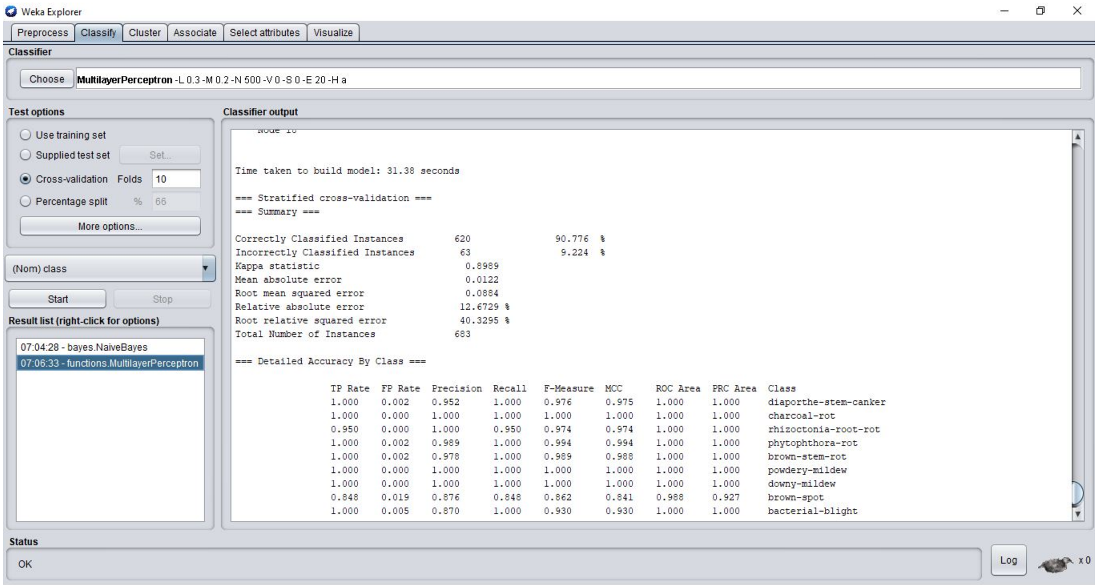

FIGURE 6.5: Multilayer Perceptron

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	1.000	0.002	0.952	1.000	0.976	0.975	1.000	1.000	diaporthe-stem-canker
	1.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	charcoal-rot
	0.950	0.000	1.000	0.950	0.974	0.974	1.000	1.000	rhizoctonia-root-rot
	1.000	0.002	0.989	1.000	0.994	0.994	1.000	1.000	phytophthora-rot
	1.000	0.002	0.978	1.000	0.989	0.988	1.000	1.000	brown-stem-rot
	1.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	powdery-mildew
	1.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	downy-mildew
	0.848	0.019	0.876	0.848	0.862	0.841	0.988	0.927	brown-spot
	1.000	0.005	0.870	1.000	0.930	0.930	1.000	1.000	bacterial-blight
	0.900	0.000	1.000	0.900	0.947	0.947	1.000	1.000	bacterial-pustule
	1.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	purple-seed-stain
	0.977	0.000	1.000	0.977	0.989	0.988	1.000	1.000	anthracnose
	0.300	0.018	0.333	0.300	0.316	0.297	0.847	0.306	phyllosticta-leaf-spot
	0.868	0.029	0.823	0.868	0.845	0.821	0.988	0.928	alternarialeaf-spot
	0.791	0.027	0.818	0.791	0.804	0.775	0.982	0.920	frog-eye-leaf-spot
	1.000	0.001	0.938	1.000	0.968	0.968	1.000	1.000	diaporthe-pod-&-stem-blight
	1.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	cyst-nematode
	1.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	2-4-d-injury
	1.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	herbicide-injury
Weighted Avg.	0.908	0.011	0.907	0.908	0.907	0.896	0.990	0.950	

Figure 6.6: Multilayer Perceptron Table

CHAPTER 7

FUTURE SCOPE

In order to improve the process of irrigation, smart irrigation project and applications are developed by The Institute of Food And Agriculture Services (UF-IFAS), with the help of US department of agriculture. The applications are made available to provide real time irrigation schedule for selected crops. They have used the trending smart phone technology for managing urban and agricultural irrigation. Various applications like Citrus app, Turf app, Strawberry app and Vegetable app, have been developed in which real-time weather data is given as input. In the application, user can register their farms and receive push notification regarding expected changes in weather so that irrigation can be scheduled accordingly. Analysis of data for the applications by comparison of water volume using entered information to the suggestions provided by smartphone applications. Various irrigation characteristics like rooting depth, rain, depletion allowed etc. are considered. Further improvements in the application is made by taking in the consideration of comments by stack holders. Also they are being tested throughout Honda and Georgia for experimental purpose. Mobile application- plantix developed by PEAT, Germany is used for plant disease diagnostics for gardeners and small holder farmers. It works as an automated process. As most of yield is lost due to pathogens and pests, the applications supports small holder gardeners and farmers to detect and find the plant damages early and hence control them fast. The application only needs a simple smartphone picture that is sent to the server and recognized by image recognition software. Later, measures to control the pathogens and pest are sent back to the user using push messages. It uses artificial intelligence and helps farmers to treat diseases early.

CHAPTER 8

CONCLUSION

In this paper automatically shut down the rainfall forecast for all problems faced by the agriculture sector by monitoring soil moisture, irrigating the crops, and monitoring the weather until the humidity is recovered. Using this method, you can save manpower and water to improve production and ultimately profitability. Automated irrigation is feasible and cost-effective to improve aquaculture for agricultural products. The system provides a feedback control system that effectively monitors and controls all activities of the irrigation system.The Plant Disease Recognition System has been developed to check if the plant is healthy and if any disease is detected, the name of the particular disease. All of these are integrated into the Android app for the ease of the user. Irrigation is a continuous process, while recognizing that the plant leaves are captured and the end of it is done only at the request of the user. There is a provision to override automatic irrigation and manually irrigate. This smart irrigation demonstrates that the irrigation system works automatically and regulates irrigation water with out the manual. Using this method, you can remotely control the pump and relay board, which opens up the possibility to control the flow of water. The irrigation system is automated depending on the sensor report. The pump is operated by weather conditions, rainfall and temperature conditions.The future goal is to train all plant species. The code is already drone compatible and ready for real-time video capture. In future it can be used for real-time capture and immediate processing of the field.

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