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Classification and Prediction of Plant Diseases Based on AI

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ABSTRACT

This work presents a machine learning model, in the form of MATLAB The business logic in Python uses Hybrid ensemble Learning techniques in order to predict the disease present in the plant or in its leaves. The proposed system will integrate the data obtained from plant photos and by applying machine learning algorithms and a prediction of most suitable crops according to current environmental conditions is made. This provides young farmers with a variety of options of crops that can be cultivated. Machine learning is concerned with the development of computer programs that can access data and learn on their own. Plant Disease prediction solves one of precision agriculture's most difficult issues, and several models have been proposed and validated so far. Since plant diseases are affected by a variety of factors such as climate, weather, soil, fertilizer usage, and seed variety, this issue necessitates the use of multiple datasets. This suggests that predicting plant disease is not a simple task; rather, it entails a series of complex steps. Farmers are the core of the agricultural system. Agriculture is an important part of a country's development because, as everyone knows, a country's gross domestic product must be equitable. Farmers are critical to the agricultural system's success because crops must be planted and processed for it to work. A prototype for a real-time plant disease prediction algorithm in Python using Hybrid Machine Learning and Data Analytics was created to assist these farmers. Machine learning is a subset of artificial intelligence (AI) that enables computers to learn and evolve without being explicitly programmed.

Keywords:Artificial Neural Network, Gray Level Co-occurrence Matrix (GLCM), Image segmentation

1. INTRODUCTION

Leaf spot is a common descriptive term applied to a number of diseases affecting the foliage of ornamentals and shade trees. The majority of leaf spots are caused by fungi, but some are caused by bacteria. Some insects also cause damage that appears like a leaf spot disease. A symptom of plant disease is a visible effect of disease on the plant. Symptoms may include a detectable change in color, shape or function of the plant as it responds to the pathogen. Leaf wilting is a typical symptom of verticillium wilt, caused by the fungal plant pathogens Infectious plant diseases are caused by living (biotic) agents, or pathogens. These pathogens can be spread from an infected plant or plant debris to a healthy plant.

Microorganisms that cause plant diseases include nematodes, fungi, bacteria, and mycoplasmas. Leaf spot is a condition caused by fungus and bacteria that result in dark, black splotches to form on the leaves of infested plants. These spots are mainly a cosmetic issue, but severe cases can be detrimental to the plants health.

Plant Diseases:

Disease fungi take their energy from the plants on which they live. They are responsible for a great deal of damage and are characterized by wilting, scabs, moldy coatings, rusts, blotches and rotted tissue.

1.Common Rust: Common rust is caused by the fungus Pucciniasorghi and occurs every growing season. It is seldom a concern in hybrid corn. Rust pustules usually first appear in late June. Early symptoms of common rust are chlorotic flecks on the leaf surface. These soon develop into powdery, brick-red pustules as the spores break through the leaf surface. The leaf tissue around the pustules may become yellow or die, leaving lesions of dead tissue

2.Polysora: Polysora rust is a fungal disease that can become a major constraint to maize production in temperate regions. Damage is most serious in early infected plants and when disease spreads to leaves above the ear which contribute most to grain filling. It has been estimated that reductions in yield as high as 8% are possible for each 10% of total leaf area infected1. The disease is caused by Puccinia polysora

3.Banded Leaf and Sheath Blight (BLSB):

This disease caused by the basidiomycetes fungus. The disease appears at pre-flowering stage in 40-50 days old plants but can also occur on younger plants. Symptoms develop on leaves, sheaths and stalks and can later spread to ears. On leaves and sheaths, a number of soaked, discolored concentric bands and rings are visible, often brown, tan or gray in color1.The disease is difficult to control through either fungicides or crop rotation alone. Inheritance studies have indicated digenic and oligogenic nature of disease resistance

Infectious plant diseases are caused by living (biotic) agents, or pathogens. These pathogens can be spread from an infected plant or plant debris to a healthy plant.

Microorganisms that cause plant diseases include nematodes, fungi, bacteria, and mycoplasmas. Leaf spot is a condition caused by fungus and bacteria that result in dark, black splotches to form on the leaves of infested plants. These spots are mainly a cosmetic issue, but severe cases can be detrimental to the plants health.

Removal of diseased plant tissues on the plant itself is your next line of defense. Prune out diseased foliage, twigs or branches, hand pick blighted camellia blossoms as they appear and dispose of these in the trash. Avoid unnecessary pruning; pruning causes wounds, which can be entry sites for decay and disease organisms. Sanitize pruning equipment to avoid transmitting disease to healthy plants. Avoid overhead irrigation – splashing water spreads fungal spores and wet foliage promotes some foliar and fruit diseases such as leaf spots, rusts, anthracnose, and brown rot.

Prevention:

Healthy soils and correct growing conditions are the best ways to prevent many plant problems from occurring. But if you notice wilting, mold, rust, blotches, scabs or decaying tissue on your plants it's time to hit them with our organic fungicides and disease fighters. Most are made from naturally-available oils and other components; some are even listed with for use on organic gardens.Removal of diseased plant tissues on the plant itself is your next line of defense. Prune out diseased foliage, twigs or branches, hand pick blighted camellia blossoms as they appear and dispose of these in the trash. Avoid unnecessary pruning; pruning causes wounds, which can be entry sites for decay and disease organisms. Sanitize pruning equipment to avoid transmitting disease to healthy plants. Avoid overhead irrigation – splashing water spreads fungal spores and wet foliage promotes some foliar and fruit diseases such as leaf spots, rusts, anthracnose, and blsb. Plant diseases have turned into a dilemma as it can cause significant reduction in both quality and quantity of agricultural products. Automatic detection of plant diseases is an essential research topic as it may prove benefits in monitoring large fields of crops, and thus automatically detect the symptoms of diseases as soon as they appear on plant leaves. The agriculture system is supported by farmers. Agriculture, as is well known, is an integral part of a country's development. Agriculture is very important in India's economy and job market. One of the most common problems faced by Indian farmers is that they do not choose the appropriate crop for their soil. One of the most popular issues that Indian farmers face is failing to protect their crops/plants in time from diseases..

2. LITERATURE REVIEW

Detecting plant diseases is a vital research topic in the area of machine learning and computer vision. These techniques use plant photos for the purpose of identifying diseases [1]. Currently, machine/computer vision-based plant disease detection technology has been used in agriculture and has mostly supplanted the conventional method of identification using the naked eye. Typical image processing algorithms or humanmade features and classifiers are often utilized for machine vision-based plant disease identification methods [2]. In most cases, the imaging scheme that is constructed using this kind of technology takes into account the specific characteristics of plant diseases. It also chooses the most effective light source and recording angle, which is beneficial for the purpose of obtaining photographs with consistent lighting.. Although meticulously developed imaging schemes can significantly minimise the complexity of traditional algorithm design, they can raise the cost of the application. It is often unrealistic to anticipate that traditional algorithms, which were created to completely minimise the impact of scene changes on identification results [3],would be successful in a natural setting.In a natural setting that is truly complex, identifying plant diseases can be difficult due to a number of factors. These variables include a lack of contrast, a modest contrast between the lesion area and the background, significant variations in the size and kind of the lesion area, and a high degree of noise in the lesion image. Under addition, there are a number of interruptions that occur while taking images of plant diseases in natural light. Currently, typical classical approaches frequently look ineffective, and it is challenging to produce improved detection results.

3.PROPOSED METHODOLOGY

The occurrence of plant diseases has a negative impact on agricultural production. If plant diseases are not discovered in time, food insecurity will increase [1]. Early detection is the basis for effective prevention and control of plant diseases, and they play a vital role in the management and decisionmaking of agricultural production. In recent years, plant disease identification has been a crucial issue. Disease-infected plants usually show obvious marks or lesions on leaves, stems, flowers, or fruits. Generally, each disease or pest condition presents a unique visible pattern that can be used to uniquely diagnose abnormalities. Usually, the leaves of plants are the primary source for identifying plant diseases, and most of the symptoms of diseases may begin to appear on the leaves Artificial intelligence has a huge impact in all Industrial Sectors. Lately, Artificial

Intelligence (AI) has been progressing at an outstanding speed. AI accomplished solving numerous problems and saving a profitable resource by minimizing environmental deterioration. Artificial Intelligence is making a revolution

In any country, Agriculture depends on the quality and quantity of farming products, particularly plants. In agricultural production, plant infections are responsible for significant economic losses. To treat and monitor them, it is important to detect and classify plant diseases promptly. The issue of efficient defense of plant diseases is firmly connected to the issues of reasonable horticulture and environmental changes. For the detection and identification of plant diseases, various methods have been presented. Research work builds up the advanced processing environment to distinguish the diseases utilizing infected pictures of different leaves.

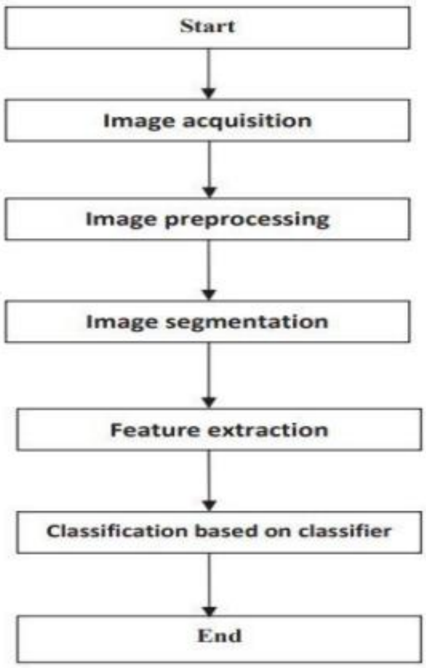

Figure 1: Proposed Plant Dieses Detection Steps

Image Acquisition: In this step, we use digital camera, mobile phone to capture the leaf images.

Image Preprocessing: After Acquisition, when the image is not satisfactory and the region of interest are not clear then we use image preprocessing techniques to remove commotion in the images.

Cleansing, Integration, Transformation and Reduction are some image preprocessing techniques. Images Enhancement and Filtering In this project image improvement that is the improvement of digital image quality with none of the data concerning the first supply image degradation. The enhancement of the image starts by first converting the gray scale image to black and white image this is done by the use of function im2bw(gray image).

AdaptiveHistogram Equalization

A histogram transformation is a pixel-by-pixel intensity transformation. A convenient representation of contrast of an image, plots the number of pixels at each intensity value. As low contrast images have narrow distributions and high contrast images have broad distributions. The probability of occurrence of intensity level r_k in a digital image is approximation equation is

$$p(r_k) = \frac{n_k}{MN}$$

Where

K=0,1,2………L-1

MN=Total number of pixels in the image

n_k = number of pixels that have intensity of r_k.

Histogram equalization is a technique for adjusting image intensities to enhance contrast. Histogram equalization is used to enhance contrast. It is not necessary that contrast will always be increase.The histogram in the context of image processing is the operation by which the occurrence of each intensity value in the image is shown in below. Normally, the histogram is a graph showing the number of pixels in an image at each different intensity value found in that image. For an 8-bit grayscale image there are 256 different possible intensities, and so the histogram will graphically display 256 numbers showing the distribution of pixels amongst those grayscale values. Histogram equalization is the technique by which the dynamic range of the histogram of an image is increased. HE assigns the intensity values of pixels in the input image such that the output image contains a uniform distribution of intensities. In fig 4.1 shows, improves contrast and the goal of HE is to obtain a uniform histogram. This technique can be used on a whole image or just on a part of an image. This method usually increases the global contrast of many images, especially when the usable data of the image is represented by close contrast values. Through this adjustment, the intensities can be better distributed on the histogram.

Clustering segmentation

Clustering uses machine learning (ML) algorithms to identify similarities in customer data. Simply put, the algorithms review your customer data, catch similarities humans might've missed, and put customers in clusters based on patterns in their behavior. Some examples include finding shoppers who tend to buy a full outfit as visually displayed rather than self-coordinating and buying apparel pieces separately. Another example is vitamin shoppers who like to stock up on promotional offers versus those who restock on a regular cadence. Those that "stock-up" on vitamins, make-up, or other items may not be back to shop for an extended period of time. It may take some creative messaging and offers to get them to purchase outside of their normal cycle.

K-Mean Clustering

It is one of the techniques for the clustering concept in the data mining process and is very famous algorithm for the K-means clustering, because it is similar or simpler and easier in computation of an efficient K-means clustering algorithm. It is the simplest unsupervised learning algorithms that solve the well known clustering problems. K -means algorithm is an unsupervised clustering algorithm that classified in the input data points into multiple classes based on their intrinsic distance from other dataset points of his cluster is a method of vector quantization, originally from signal processing, that is popular for cluster analysis in data mining. K-means clustering aims to partition n observations into k clusters in which each observation belongs to the cluster with the nearest mean, serving as a prototype of the cluster. This results in a partitioning of the data space.K-means is one of the simplest unsupervised learning algorithms that solve the well-known clustering problem. The procedure follows a simple and easy way to classify a given data set through a certain number of clusters (assume k clusters) fixed a priori. The main idea is to define k centroids, one for each cluster. These centroids should be placed in a cunning way because of different location causes different result. So, the better choice is to place them as much as possible far away from each other. The next step is to take each point belonging to a given data set and associate it to the nearest centroid. When no point is pending, the first step is completed and an early group age is done. At this point we need to re-calculate k new centroids as centers of the clusters resulting from the previous step. After we have these k new centroids, a new binding has to be done between the same data set points and the nearest new centroid. A loop has been generated. As a result of this loop, we may notice that the k centroids change their location step by step until no more changes are done.After the pre-processing stage, segmentation of lesion was done to get the transparent portion of the affected area of breast. On transformation, K-means clustering method is applied to the image to segment the breast lesion area based on thresholding. In K-means clustering algorithm, Segmentation is the initial process of this work, at the cluster centers, cost junction must be minimized which varies with respect to memberships of user inputs.

K-means clustering is used in the proposed procedure for segmentation to a certain extent than Active counter clustering approach because of its speed of operation with maintaining the highest accuracy. K means clustering procedure combines the properties of jointly possibility and K means clustering approaches as shown in figure 2. Here the membership functions are generated in the probability-based manner to gets better detection. Among those detected tumors, the highest accurate cancer regions considered as ROI. The automatic extraction of ROI is difficult. So, ROIs are obtained through possibility cropping, which are based on location of abnormality of original test images. Here the membership functions are generated in the probability-based manner to gets better detection. Among those detected Cancer regions, the highest accurate Cancer region is considered as ROI. Finally, this algorithm aims at minimizing an *objective function*, in this case a squared error function. The objective function is given by

$$J(V) = \sum_{i=1}^{c} \sum_{j=1}^{c_i} \left\| x_i - v_j \right\|^2 \qquad (4.1)$$

Algorithm:

1. Give the no. of cluster value as k.

2. Randomly choose the k cluster centres.

3. Calculate mean or centre of the cluster.

4. Calculate the distance between each pixel to each cluster centre.

5. If the distance is near to the center, then move to that cluster.

6. Otherwise move to next cluster.

7. Re-estimate the center

8. Repeat the process until the center doesn't move.

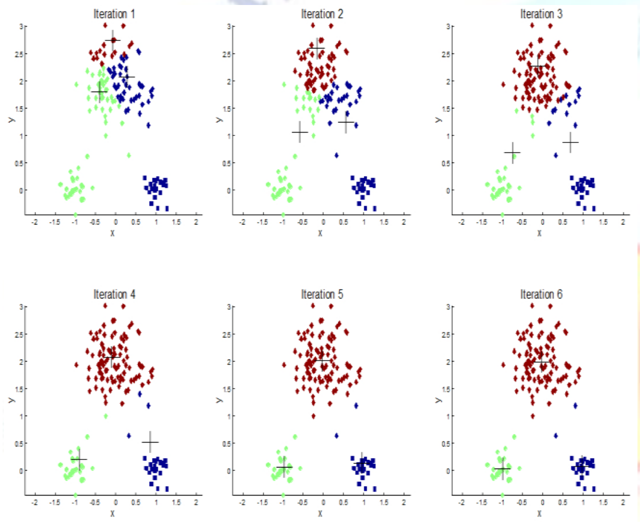

Figure 2: Different ways of clustering the same set of points

Figure 2 shows the different ways of clustering the same set of points. First choose the number of clusters as three. Choose randomly the three cluster centers.Calculate the distance between each pixel to each cluster center. If the distance of pixel is near to the center the move to that cluster. Otherwise move to next cluster. Repeat the process until the center doesn't move. Fig 4.2 represents the diagrammatic representation of K-mean clustering algorithm.

K-means is simple and can be used for a variety of data types. It is also a quite efficient, even though multiple runs are often performed. Some variants including bisecting K-means, are even more efficient, and are less susceptible to initialization problems. K-means is not suitable for all types of data, however. It cannot handle non-globular clusters or clusters of different sizes and densities, although it can typically find pure sub clusters if a large enough contains outlier. Outlier detection and removal can help significantly in such situations

Feature Extraction

GLCM

After treating the GLCM' s Gray co props function may be used to derive several statistics from them. These derivedstatistics gives information about the texture of an image. By calling the gray props function you can specify the statistics you want. The following table 1 illustrates the statistics you have been derived.

Texture feature based on GLCM

Texture analysis refers to the characterization of regions in an image by their texture content. Texture analysis attempts to quantify intuitive qualities described by terms such as rough, smooth, silky, or bumpy as a function of the spatial variation in pixel intensities. In this sense, the roughness or bumpiness refers to variations in the intensity values, or gray levels.

Texture analysis is used in a variety of applications, including remote sensing, automated inspection, and medical image processing. Texture analysis can be used to find the texture boundaries, called texture segmentation. Texture analysis can be helpful when objects in an image are more characterized by their texture than by intensity, and traditional thresholding techniques cannot be used effectively

Statistics	Description
Homogeneity	It measures the closeness of the distribution of elements between the GLCM and the GLCM diagonal
Energy	It is known as the uniformity or the Angular second moment. It provides the sum of the square of the elements in the GLCM
Correlation	It measures the occurrence of the joint probability of the specified pixel pairs.
Contrast	In the Gray level co-occurrence matrix it measures the local variations.

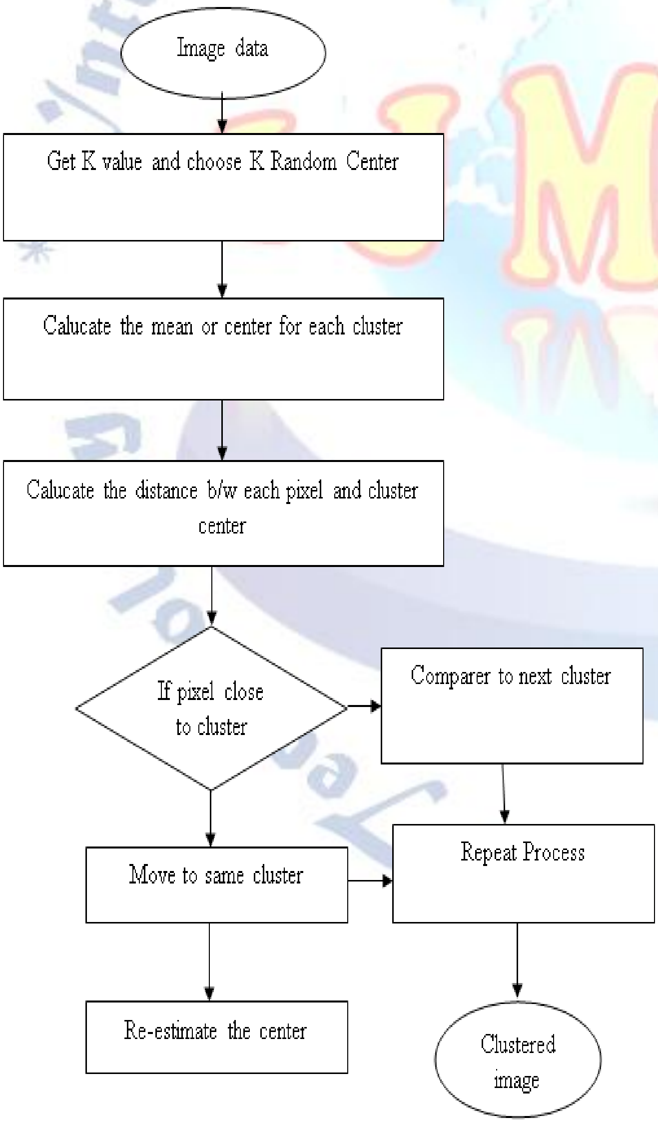

Figure 3: Flowchart for k-means Clustering

Table 1: Statistics related to texture of the image

Using the texture filter functions these statistics can characterize the texture of an image because they provide information about the local variability of the intensity values of pixels in an image. For example, in areas with smooth texture, the range of values in the neighborhood around a pixel will be a small value; in areas of rough texture, the range will be larger. Similarly, calculating the standard deviation of pixels in a neighborhood can indicate the degree of variability of pixel values in that region. And the statistics can be explained in the following tabular column.GLCM creates a matrix with the directions and the distance between the pixels, and then extracts meaningful statistics from the matrix as texture features. GLCM is composed of the probability value, it is defined as $P(i,j|d,\theta)$ which expresses the probability of the couple pixels at θ direction and the d interval. When θ and d are det6ermined $P(i,j|d,\theta)$ is shown by $P_{i,j}$. Distinctly GLCM is a symmetry matrix its level is determined by the image gray level. Elements in the matrix are computed by the equation shown as the following

$$P(i,j|d,\theta)=\frac{P(i,j|d,\theta)}{\sum_i\sum_j P(i,j|d,\theta)}$$

GLCM expresses the texture feature according the correlation of the couple pixels Gray level at different positions. It quantificationally describes the texture features. But here mainly four things are considered they are energy, contrast, entropy and the inverse difference.

Energy:

$$E=\sum_x\sum_y p(x,y)^2$$

It is a gray scale image texture measure of the homogeneity changing reflecting the distribution of the image gray-scale uniformity of the image and the texture.

Contrast:

Contrast is the main diagonal near the moment of inertia, Which measures the value of the matrix is distributed and images of local changes in the number, reflecting the image clarity and the texture of the shadow depth if the contrast is large then the texture is deeper.

$$I = \sum\sum (x-y)^2 p(x,y)$$

Entropy:

Entropy measures image texture randomness, when the space co-occurrence matrix for all values is equal, it achieved the minimum value; on the other hand, if the value of co-occurrence matrix is very uneven, its value is greater. Therefore, the maximum entropy implied by the image gray distribution is random.

$$S = -\sum_x \sum_y p(x,y) \log p(x,y)$$

Inverse difference:

It measures local changes in image texture number. Its value in large is illustrated that image texture between the different regions of the lack of change and partial very evenly.Here $p(x,y)$ is the gray level value at the co-ordinate (x,y)

$$H = \sum_x \sum_y \frac{1}{1+(x-y)^2} p(x,y)$$

In this phase the features of the given input image is been extracted. These features include smoothness, entropy, variance, skewness, idm, correlation, homogeneity, mean and standard deviation. And on the basis of these features the image is analyses and the detection of the dises region is been done. Below in there are output result of an image uptill the feature extraction phase of the project.

Data base

This database is a clearinghouse of information about models developed for economically important crop and turf diseases in California. A model is included in the database if it uses weather, host, å and/or pathogen data to predict risk of disease outbreak. This database is a part of a project called "PestCast," a regional weather network to support the development, validation, and implementation of crop disease models.

Machine level supervised classification

Classification is a supervised machine learning method where the model tries to predict the correct label of a given input data. In classification, the model is fully trained using the training data, and then it is evaluated on test data before being used to perform prediction on new unseen data based on A support vector machine (SVM) is a type of supervised learning algorithm used in machine learning to solve classification and regression tasks; SVMs are particularly good at solving binary classification problems, which require classifying the elements of a data set into two groupsFeature extraction is the techniques or method that used to measure of difference characteristics of image segments also its process to represent raw image in its reduced form to facilitate decision making such as pattern classificationIf we drew a perpendicular line from each point to the regression line, and took the intersection of those lines as the approximation of the original data point, we would have a reduced representation of the original data that captures as much of the original variation as possible. Notice that there is a second regression line, perpendicular to the first, shown in figure 4.

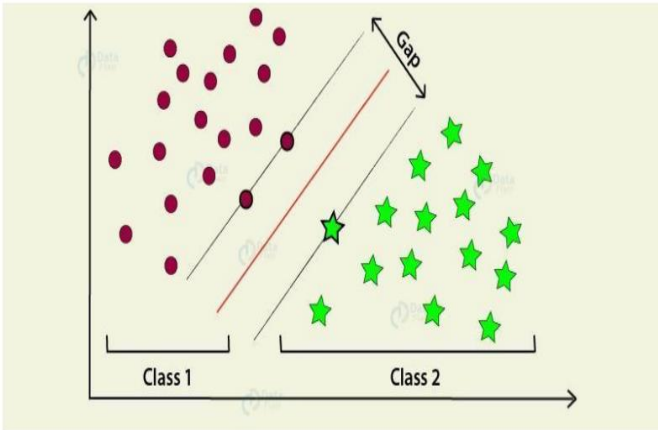

Figure 4: SVM Model

The support vector machine algorithm's goal is to find a hyper plane in an N dimensional space (N — the number of features) that categorizes data points clearly. There are several different hyper planes that could be used to distinguish the two types of data points (as seen in fig 4.9). Our aim is to find a plane with the greatest margin, or the greatest distance between data points from both grou ps. Maximizing the margin gap provides some reinforcement, making it easier to classify potential data points. Hyperplanes are decision boundaries that aid in data classification. Different groups may be assigned to data points on either side of the hyperplane. The hyperplane's dimension is also determined by the number of functions. If there are only two input features, the hyperplane is just a line. The hyperplane becomes a two-dimensional plane when the number of input features reaches three. When the number of features reaches three, it becomes impossible to picture. When we have two groups classification problems, SVM will function perfectly. For example, whether or not diseases are present in the plant, th ese types of issues would be ideal for SVM. If the number of rows in the dataset reaches the limits, the SVM model will not provide perfect accuracy.

4. RESULTS& DISCUSSION

Image acquisition involves capturing the images with the help of digital camera. Our study focused on the diseased images of leaf show in figure 5. The image enhancement is carried out to increase the contrast. The RGB images are converted into grey images using colour conversion Image segmentation helps in the detection of objects and boundary line of the image. In our study K-mean clustering is done for classification of objects based on a set of features into K number of clusters show in figure 6. In feature extraction method features such as color, texture, morphology and structure are used in plant disease detection.

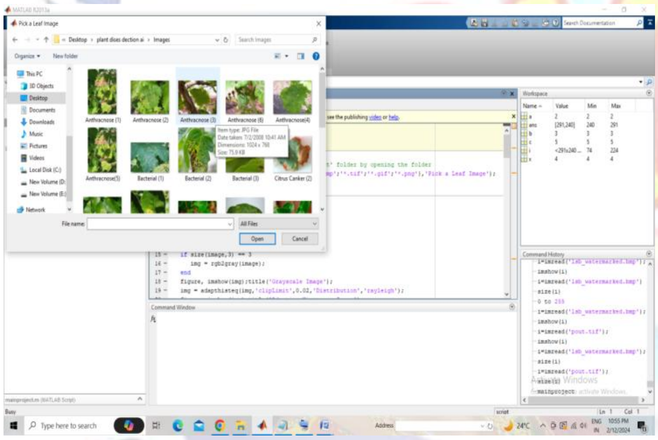

Figure 5: Browse the Input Data

GLCM Features is used in which the texture and color of the image are considered. Classification is used in the interpretation of the extracted diseased region in an image which helps in the identification of the type ofdisease used SVM show in figure 7 and 8

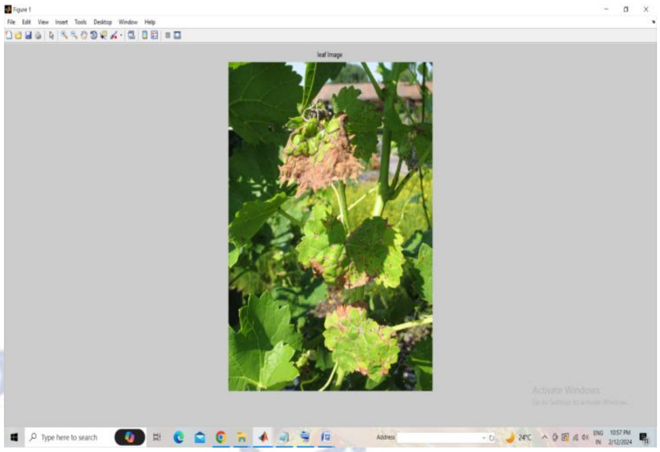

Figure 6: Diseased Leaf Input Image Leaf

We can take input by used image acquisition process

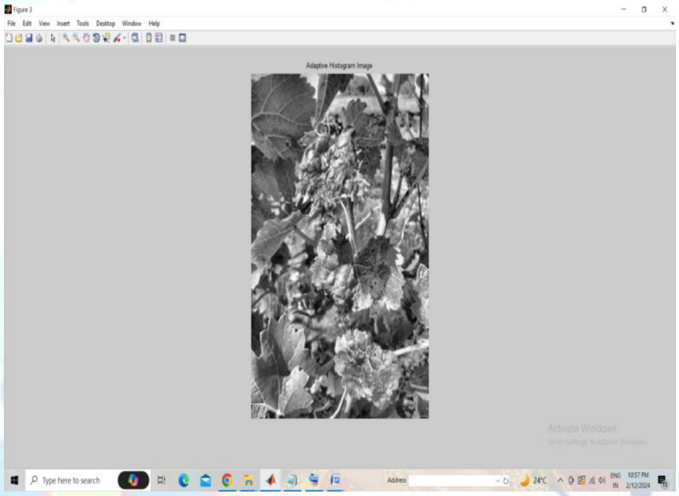

Figure 7: Preprocessing of Leaf by adaptive histogram equalization method

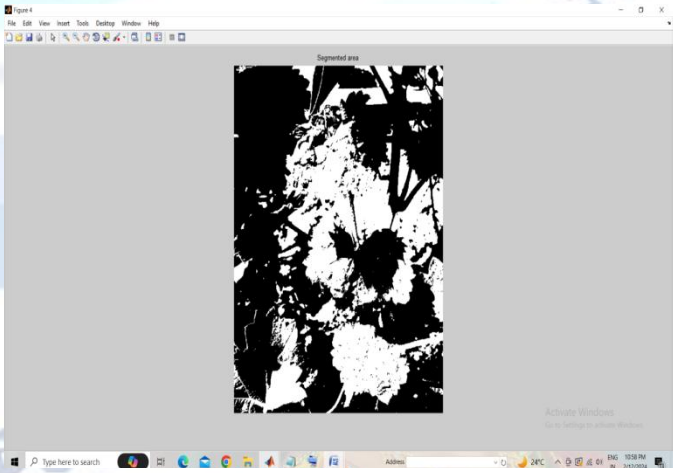

Figure 8: Leaf disease detection by using segmentation method

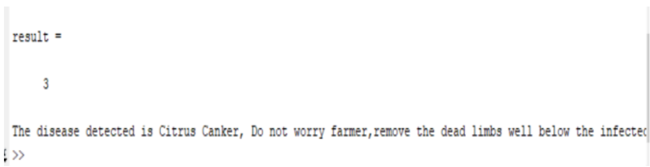

Figure 9: Leaf diseaseclassification

4.CONCLUSIONS

This paper presents the survey on different diseases classification techniques used for plant leaf disease detection and an algorithm for image segmentation technique that can be used for automatic detection as well as classification of plant leaf diseases later some of those ten species on which proposed algorithm is tested. Therefore, related diseases for these plants were taken for identification. With very less computational efforts the optimum results were obtained, which also shows the efficiency of proposed algorithm in recognition and classification of the leaf diseases. Another advantage of using this method is that the plant diseases can be identified at early stage or the initial stage.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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