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ORIGINAL ARTICLE **OPEN ACCESS**

Segmentation, Classification and Detection of Diseases on Brinjal Leaves based on Artificial Neural Network

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ABSTRACT

Agriculture is undoubtedly the cornerstone of our state Odisha. A slogan "Jay Jawan, Jay Kisan" was coined by the 2nd Prime Minister of India, Lal Bahadur Shastri holds the utmost pertinence not only during his governance period but also thousands of years to come. Keeping in view the importance of the agricultural productivity, the identification of plant leaf diseases plays a pivot role in augmenting agricultural productivity. Agricultural productivity is not exclusively a source of livelihood but also provides a pave of how to live life. This is the primary source of our daily eatable foods as well as the elementary foundation of our economic development. In a pragmatic view, our economy highly depends on it, so we need to bolster our agricultural productivity by providing bits of technical support to diagnose and detect the diseases appeared in plant in an automatic manner. Like human beings, numerous diseases are identified from time to time in plants which is very natural. Almost all diseases in plants are recuperated if it is detected in time. Manual detection of disease makes it too tardy to detect by calling the experts from outside who will take much time to monitor and diagnose about the disease. Earlier, the calling of plant experts were done which requires huge processing time. But, now due to this ongoing pandemic COVID-19 situation, we must need to avoid people with maintaining social distances. The 2nd wave of this hair-raising COVID-19 pandemic and its agonizing consequences, prompting the farmers to maintain social distances from other persons, they may be the plant expertise. As a result, we were inspired ourselves to develop this paper where brinjal plant disease detection is done by using the symptoms that are seen on the brinjal leaves (collected from some of the local regions of Balasore District with the help of some image processing techniques that involves the steps like image acquisition, image pre-processing, image segmentation, feature extraction and classification, which will facilitate the work of the farmer and will also enhance the productivity which is either directly or indirectly fosters our economy.

Key Word *- Image acquisition, Segmentation, feature extraction*

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INTRODUCTION

The curiosity of using agricultural foods in our daily life at anywhere & round the clock during all the seasons ignited us to develop this paper. This paper is strictly emphasizing on augmenting productivity which further enhances our livelihood along with our economy by detecting diseases. As the diseases of plants are predestined, the identification of diseases plays an important role in agriculture. Many components like bacteria, fungi, virus etc. are unconditionally necessary for occurrence of diseases in plants that affects mostly the leaves. Accordingly, classification & identification of diseases is a vital task. Previously, disease detection is straight forwardly occurred through naked eye observations by experts, which may lead to directly face off with corona virus in today's ongoing scenario, and also diagnosis by experts require continuous observation, which might be very costly in large farms. To take the advantage of technological advancement and discourage the lengthy as well as costly process of manual disease detection imposed with lots of constraints, we analyze some images of locally collected brinjal leaves from Balasore district to extract the features of disease spot according to color, texture and other characteristics which results an automatic detection of plant disease in this paper. Instead of consulting agricultural paid experts, which is time consuming also, certain automatics techniques prove to be beneficial in caring the large farms. These diseases affected areas are measured by some image processing techniques and also this technique will evaluate the difference in the colors of disease affected area. Different algorithms are used for identifying these areas.

LITERATURE SURVEY

In the area of agricultural applications, several researchers have suggested various image processing techniques for the detection of plant diseases. It is very much important to discern some of the erstwhile research works done vis-à-vis this area, so that we are able to flawlessly proceed with the right direction. Detection of diseases in plants in an automatic manner is a crucial research topic which may help the farmers in keeping an eye on the large crop fields to quickly recuperate the diseases just immediately they appear on the leaves of the plant. Fast and speedy recuperation of diseases can only be possible if the right and accurate detection of disease is occurred. With the help of various image processing techniques, we can detect disease accurately within a very nominal time period, so that proper medications can be done for achieving quick recovery from the affected diseases. Thus, a well-structured methodical plant disease detection model is necessarily needed.

This paper [I] titled "Detection of Plant Leaf Diseases using Image Segmentation and soft computing techniques" includes seven different steps as its proposed methodology. The very fast and foremost step is image acquisition which basically deals with the acquisition of an image using any digital camera. To ameliorate the quality of the inputted image some preprocessing operations like clipping, image enhancements are also done. In the next step, masking of green color pixels is done to calculate the threshold value. Then two following fundamental computations are performed to obtain segments by classifying leaf diseases along with to extract the features.

The basic configuration for Genetic Algorithm starts with population. To set up a new population, dataset should be chosen from the old one. This selection is done according to their fitness. For creating new population, selection, cross over, mutation, accepting steps should be done. To shape with the unique feature of leaf images, both the texture & color of the images are considered in color co-occurrence method. At finally, classification is done by Support Vector Machine (SVM) classifier to classify and detect diseases. Here all the experiments are performed using MATLAB.

Enhanced image gives more better looks as compared to original images based on the clarity as well as quality too. Red, Green and Blue are the three fundamental colors in a digitally colored image. It is hard nut to crack the application implementation using RGB due to their range which starts from 0 to 255. Hence, the conversion should be done from RGB to gray image. Finally, for distribution of intensities of images can be carried out by applying histogram equalization to further improve the images of plant disease [2].

Monica Jhuria et al develops a model based on image processing for detection of the plant disease along with the grading of fruit in [3]. Here, researchers have applied the techniques of Artificial Neural Network (ANN) to properly detect the disease. They have constructed two different databases, where one database is strictly used for the training dataset that are already saved as diseased images and in the other hand, the second database is strictly used for the query images to be implemented. To adjust the weights of training database, back propagation technique is also used here. Three basic feature vectors such as color, morphology and textures [3] are studied here and at finally, the findings shows that the morphological features provide preferably better outcomes in comparison with other two features i.e. color and textures.

According to paper [4], the authors have researched by capturing the chili plant leaf for the intention of knowing the health status of that plant. To perform the feature extraction as well as image recognition, they have used the Matrix Laboratory tool. Here they have applied Fourier filtering, edge detection and morphological operations for the pre-processing of images. Digital Camera is used for acquiring the images and to construct the GUI a tool namely LABVIEW software is used.

While extracting the features, segmentation of the same leaf images should be done at that moment. In paper [5], they have created models by comparing two different algorithms i.e., Otsu threshold and k-means clustering algorithm for the affected leaves. Evidently, it is to say that k-means clustering provides better result than others as per the paper [5].

The captured Red, Green, Blue (RGB) images are used to identify the diseases. As per the paper [6], the first and foremost step is to apply the k-means clustering algorithm. After this, the green pixels are pointed out and then by applying ostu method, different threshold values are derived. The main method i.e. color co-occurrence method is used here to extract the features. Then the conversion is done from RGB image into HSI translation. SDGM matrix is created or initiated for the calculation of texture statistics. Features are also determined using GLCM function [6].

Chunxia Zhang, Xiuqing Wang and Xudong Li have combined developed a FPGA & DSP based methodology to observe, surveil and control the diseases in plant [7]. Basically, FPGA is used to observe and diagnose the field plant image. On the other hand, the DSP TMS320DM642 is utilized to perform the processing of encoding the image data. For transferring the image data, one single chip 2.4 GHz radio transmitter namely nRF24L01 is used. Most attractive thing is that, it gives emphasis on reducing the cost of whole

system by using multichannel wireless system.
As per the author Shantanu Phadikar and Jaya Sil [8], they have used pattern recognition to identify diseases in rice. This paper [8] delineates about a software for the identification of disease formulated on the infected rice plant images. They have used HSI model to segment the captured image and to detect the infected part, boundary along with spot detection is also used [8].
The methodology for apple leaf diseases identification is presented in this paper [9] titled "Identification of apple leaf diseases based on Deep Convolutional Neural Networks". It accurates the identification of apple leaf diseases by generating sufficient pathological images and designing a deep CNN by using AlexNet. A slight distortion is introduced to the pathological images to reduce overfitting at the experimental stage. Basically, classical Alexnet along with GoogleNet is used in deep CNN to detect the diseases in apple leaf.

BASIC STEPS FOR DISEASE DETECTION

This section basically involves some primary basic steps for detection and classification of brinjal plant diseases using digital image processing are shown below (Fig. 1).

Fig. 1 - Primary steps for brinjal plant disease detection and classification

IMAGE ACQUISITION

Acquisition of digital images of brinjal leaves are done by capturing through the mobile camera from some of the rural areas of Remuna near Khirachora Gopinath Temple, Balasore district of Odisha which are used in this paper for research purpose. The collected images are in the form of Red, Green and Blue (RGB). For the purpose of implementation, all the collected images are copied and then moved to the laptop, where the proper application will be carried out. All the collected datasets are comprising with images having the brinjal leaves with number of diseases like Altrenaria melongenae, Bacterial Wilt, cercospora leaf spot, Phomopsis Blight. Creation of color transformation structure for the rurally collected RGB leaf images are done, and then, an independent device with color space transformation for the color transformation structure is applied. Some of the collected images are illustrated below (fig. 2).

Fig.2 – Some sample image of the collected brinjal leaf images from the rural areas of Remuna, Near Khirachora Gopinath Temple, Balasore district of Odisha

IMAGE PREPROCESSING

In this step, the foremost thing is to crop the image for the need of memory space and also to remove noises appeared in the images. Also, the enhancement of images should be occurred for increment of the contrast level. To perform the above-mentioned functionalities like –

- Cropping of images
- Removal of noises
- Increasing contrast of images,

Certain pre-processing techniques are used which are written below.

- Image clipping – Using image clipping, brinjal leaf images are cropped to get the interested area of the image.
- Smoothing filter – Smoothing filter is used to smooth the images by removing the noises.
- Image enhancement – This process is carried out to increase the contrast level of the captured images.

By using equation (1) for color conversation, the RGB images are converted into gray images.

$$f(x) = 0.2989*R + 0.5870*G + 0.114*B \quad \text{----------(1)}$$

To distribute intensities of the images, histogram equalization is applied on the image just after the color conversion to enhance the images of brinjal plant diseases. Here, the cumulative distribution function is applied to distribute values of intensity [2].

IMAGE SEGMENTATION

This phase performs the partitioning of brinjal leaf images into various parts as per the same characteristics or similarities. This segmentation can be accomplished by using the methods mentioned below.

- otsu' method
- k-means clustering

Here, conversion is done from RGB image into HIS model etc.

Segmentation according to the Boundary and spot detection algorithm:

For segmentation, the principal thing is to convert RGB image into HIS model. As per the heading name "Segmentation according to the Boundary and spot detection algorithm", it is obvious that, this boundary detection and spot detection is used to find the affected part of the brinjal leaf as per the discussion in [9]. Eight connectivity of pixels are to be pondered for boundary detection with the implementation of its algorithm [9].

K-means clustering:

K-means clustering is a classification algorithm. Based on the object, this clustering is basically used to classify the set of characteristics or features into k no. of classes. This classification of object is carried out by minimizing the result of sum of the squares of the distance between the object and compatible cluster.

K-means clustering algorithm:

i) By using some random method or heuristic method, first select the center of K- cluster.
ii) To reduce the distance between the pixel and the cluster center, allocation of each pixel present in the leaf image occurred to the cluster.
iii) Then, calculate the cluster centers afresh by averaging all of the pixels in the cluster. Repeat step (ii) & step (iii) until convergence is achieved.

Ostu' Threshold Algorithm:

The process of creation of binary brinjal leaf images from that of the gray level images is called thresholding. This can be done by mounting all pixels under some threshold to zero and all pixels above some threshold to one. The Otsu algorithm [5] is described as follows:

i) Segregate pixels into two different clusters as per the threshold value.

ii) Then, obtain the mean of each and every cluster.
iii) Find the difference between the means and then square it.
iv) Then multiply the total no. of pixels of one cluster with that of the other.

The symptoms of brinjal leaf diseases is detected by the affected leaf with the change of the color of the brinjal leaf. Therefore, the following operations are performed: -

i) Greenness of the brinjal leaves is to be applied for the detection of the affected portion of the brinjal leaf.
ii) The Red (R), Green (G) and Blue (B) component are extracted from the brinjal leaf image.
iii) Computation of the threshold is done by the Otsu's method.
iv) Then, at finally the green pixels are masked and removed if the green pixel intensities are less than the calculated threshold value.

FEATURE EXTRACTION

Feature Extraction helps in identifying the object in the brinjal leaf images. Mostly, in various plant disease detection process as per the digital image processing techniques, feature extraction is applied. Different features such as color of the leaf image, morphological structure of the image, texture as well as edges of the images can be applied in different disease detection process in different plants. According to the paper [3], morphological structure provides more preferable result as compared to other features like color, texture etc. Texture shows the color distribution of the image that may be rough or hard. Furthermore, the texture feature can also be used to detect the affected area of plant.

Color co-occurrence method:

According to this method, both features of color and texture are used to generate a distinct feature for that brinjal leaf images. Here, conversion of RGB image into HSI translation is done.

$$H = \begin{cases} \text{Theta}, & \text{if } B<G \\ 360 - \text{Theta} & B>G \end{cases} \text{----------(2)}$$

$$S = 1-\frac{3}{R+G+B}[\min(R,G,B)] \text{----------(3)}$$

$$I = \frac{1}{3}(R+G+B)$$

SGDM matrix is used to calculate texture statistics and with the help of GLCM function, the feature is computed.

Color extraction of brinjal leaf using H and B components:

The brinjal leaf image is contrasted by image enhancement using the anisotropic diffusion algorithm to store the data of the infected pixels. This storing can be done before segregating the color from background [8]. H & B components of LAB & HIS color space is studied to differentiate between various parts of leaf. To clearly identify the colors of diseased leaf, a SOFM with back propagation neural network is applied.

CLASSIFICATION

Using ANN:

With the help of neural network, the learning database images are divided after the feature extraction step. These vectors of feature are studied as neurons. The function of weighted sum of inputs are acted as the output of these neurons. Different algorithms can also be used i.e. back propagation algorithm, Multiclass Support vector machines etc.

Back Propagation:

In a recurrent network, basically Back propagation Neural Network is applied. The weights associated with this neural network are allotted firmly after the trained for one time only and that can also be applied to calculate the output values for newly queried images that are absent in the learning databases.

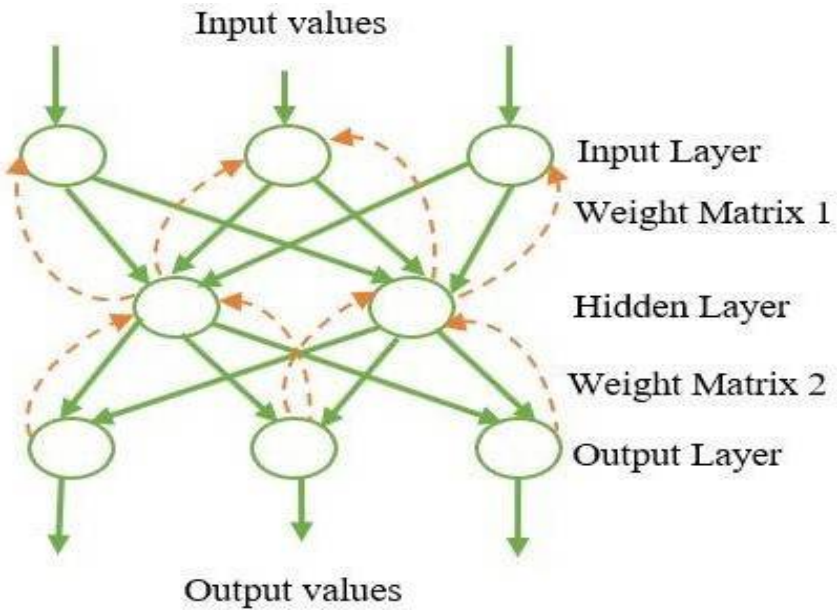

Fig.3 – Back Propagation network

Query images testing:

The weight of learning database is determined. Then, query brinjal leaf image is being tested. The following flowchart describes the working principles of testing of query image using the ANN techniques.

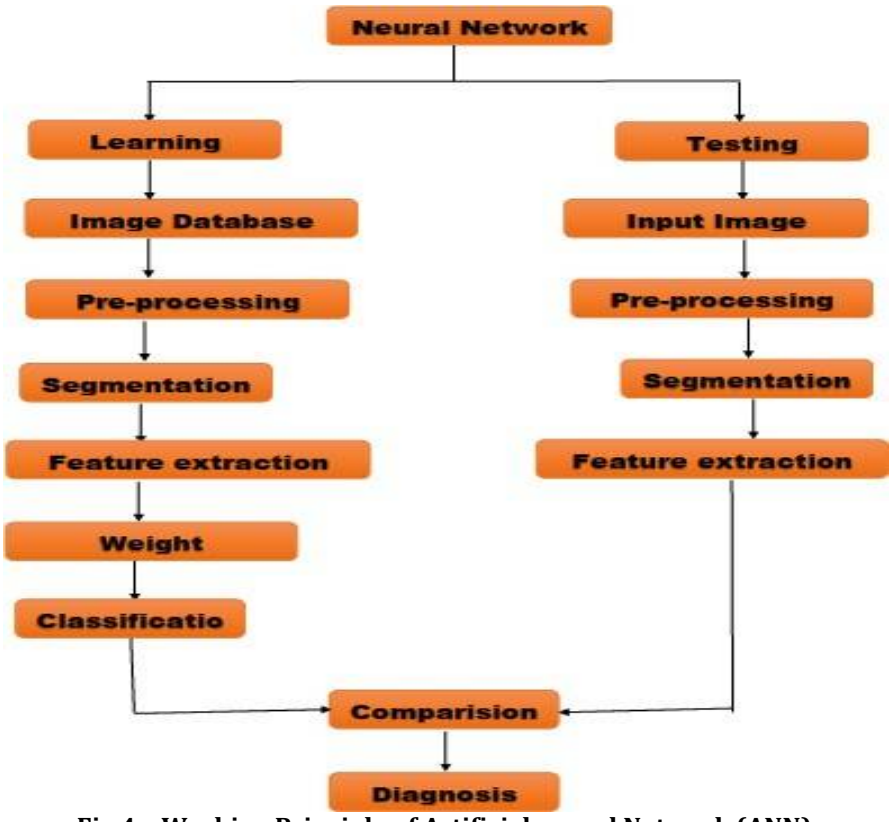

Fig.4 – Working Principle of Artificial neural Network (ANN)

OUTCOMES OBSERVED (IN FIGURE AND TABULAR FORM)

Input and Output images of different diseases detected in the leaf of the brinjal:

Fig.5 – Input and output image of brinjal leaf, where output disease is Altrenaria Melongenae disease.

Fig.6 – Input and output image of brinjal leaf, where output disease is Bacterial Wilt disease.

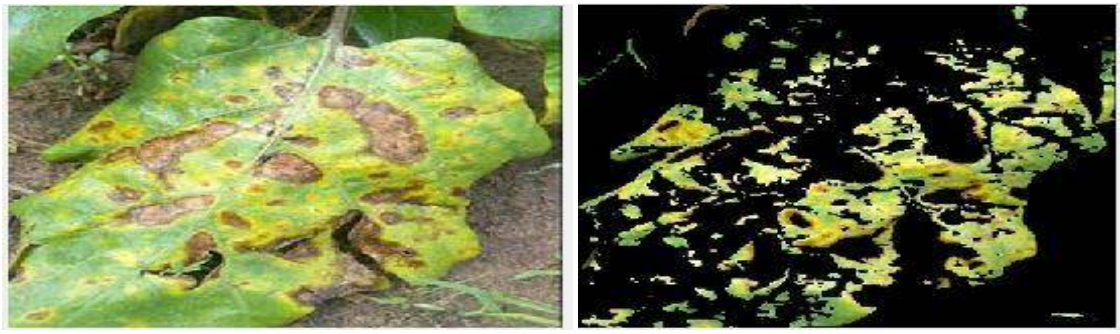

Fig.7 – Input and output image of brinjal leaf, where output disease is Cercospora leaf spot disease.

Fig.8 – Input and output image of brinjal leaf, where output disease is Phomopsis Blight disease

Segmented images after K-means clustering:

Fig.9 – Segmented by k-means clustering after image enhancement

Fig.10 – Segmented by k-means clustering after image enhancement, where the disease is Altrenaria Melongenae disease.

Fig.11 – Segmented by k-means clustering after image enhancement, where the disease is Bacterial Wilt disease.

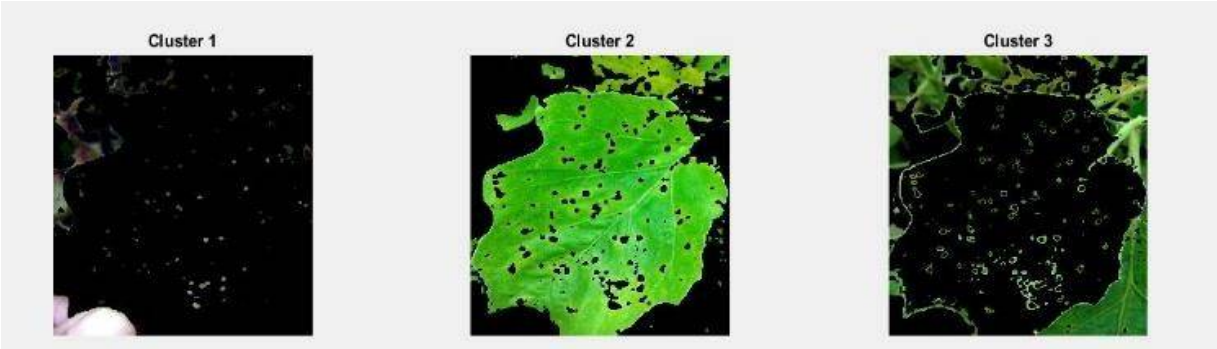

Fig.12 – Segmented by k-means clustering after image enhancement, where the disease is Cercospora leaf spot disease.

Fig.13 – Segmented by k-means clustering after image enhancement, where the disease is Phomopsis Blight disease.

Comparison of features of different diseases

TABLE 1: COMPARISION OF FEATURES FOR DIFFERENT DISEASES

NAME OF THE BRINJAL PLANT DISEASE	MEAN	S.D.	ENTROPY	RMS
Altrenaria Melongenae	31.2339	68.4516	2.27069	6.2857
Bacterial Wilt	27.7228	57.6837	2.84302	7.80587
Cercospora leaf spot	64.9343	75.0921	5.67303	11.879
Phomopsis Blight	23.4476	55.9208	2.46778	6.78086

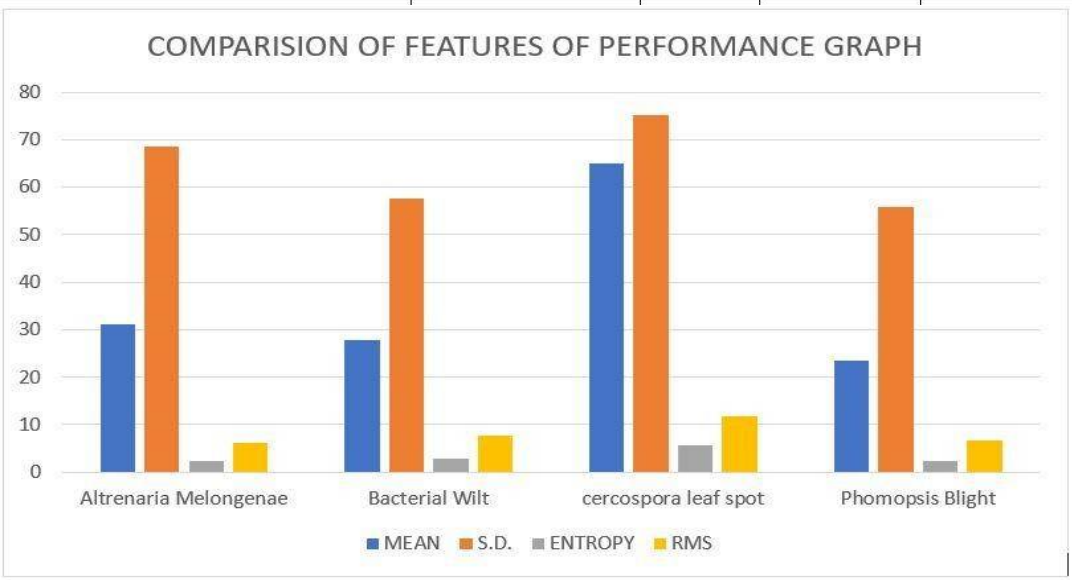

Fig.14 – Comparison of features for different diseases

Output Screen on MATLAB

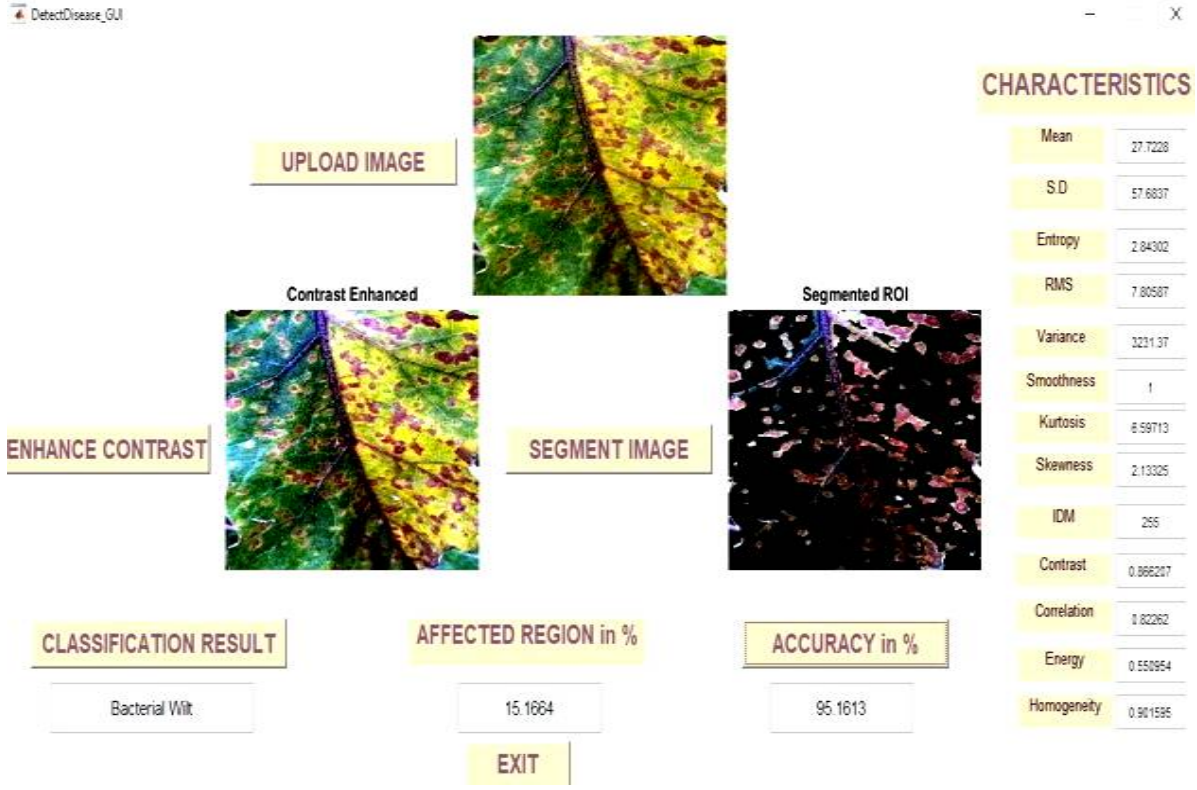

Fig.15 – Outcome Screen on MATLAB

Accuracy Graph

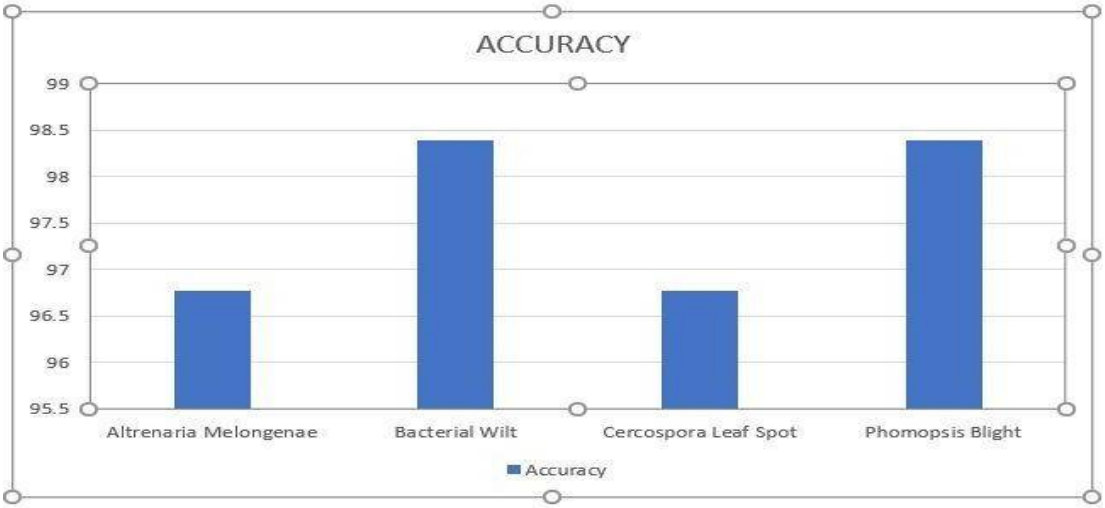

Fig. 16 -Accuracy in % for different disease

CONCLUSION

The very crucial task is to scrupulously identify as well as classify the disease in brinjal plant for the farmers to gain more profit by cultivating brinjal plants successfully. This paper analyzed several methodologies for the segmentation of infected part of the brinjal leaves. It also discussed several classification and feature extraction techniques for the extraction of the different features of brinjal leaf along with the classification of different diseases. Artificial Neural network, Back propagation algorithm, SVM etc. are used and applied effectively to correctly detect and classify several plant diseases appeared in brinjals using digital image processing techniques implemented through MATLAB.

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