Fungal Plant Disease Grading and Identification

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Abstract— The present paper proposes an innovative technique to grade the plant disease. The proposed methodology provides a digitalized approach for identifying the plant diseases. In present plant pathology reply on either naked eye prediction or on basic digitalized approaches. Hence the present system provides the agriculture sector with the enhanced algorithm which includes image processing, Feature Extraction and fuzzy logics to identify and grading the plant diseases with high accuracy. The results are proved to be accurate and satisfactory in contrast with manual grading.

Key words: Segmentation, Feature Extraction, Disease Grade

I. INTRODUCTION

The life span of human beings depends upon food. It been supplied to mankind in surplus by the agriculture sector. Agriculture sector plays a vital role in the growth and development of human race consistently. Nowadays, government has started to contribute agricultural research funding, which will ultimately lead to enhanced production in food supply. Meanwhile, there is great hurdle faced by the agriculture sector which effects the plant production in the form of plant disease. It is the crucial cause which reduces the quantity of the agricultural products produced in large scale. There is also greater compromise in the quality of the product produced. An in-depth Scientific study which includes infectious diseases and physiological factors is carried on as "Plant Pathology". This study concentrates on life cycle of the disease, economic impact, infection identification, and so on. Disease is impairment to the normal state of the plant that modifies or interrupts its vital functions such as photosynthesis, transpiration, pollination, fertilization, germination etc. Plant diseases have turned into a nightmare as it can cause significant reduction in both quality and quantity of agricultural products. Computerized application is under taken to improve the agriculture sector. Due to the manifestation and developments in the fields of sensor networks, robotics, GPS technology, communication systems etc, precision agriculture started emerging. The ultimate aim of agriculture sector is to maximise the profit, decrease in infectious diseases and change in agriculture practices to increase the yield. When it comes to handling diseases it is more important to include the attributes like grade to obtain exact treatment and recovery measures.

II. EXISTING CLASSIFICATION METHODOLOGY

Initially plant pathologists rely on naked eye grading of the infected plant. This system was not very effective when it comes to critical diseases. Hence, the computerized application of grading emerged with some basic methods to classify the infected plants. This classification is done based on the morphological structure of the plant. Classification techniques involved in this are Neural Network, Genetic Algorithm, Support Vector Machine, and Principal Component Analysis, k-Nearest Neighbour Classifier.

A. K-Nearest Neighbour

K-Nearest Neighbour is a simple classifier in the machine learning techniques. It works by classifying the nearest neighbours. Application of KNN in plant leaf classification is done by taking into account the Euclidean distance between the test samples and training samples. In this way it finds out similar measures and accordingly the class for test samples.

The main disadvantage of the KNN algorithm is that it is a slow learner, i.e. it does not learn anything from the training data. Slow to compute with large data set. Noisy data is not included to classify the disease.

B. Support Vector Machine:

Support Vector machine (SVM) is a non-linear Classifier. In SVM, the input data is non -linearly mapped to linearly separated data in some high dimensional space providing good classification performance. SVM maximizes the marginal distance between different classes. The division of classes is carried out with different kernels.

Main advantages of SVM are:

- Its prediction accuracy is high.
- Its working is robust when training examples contain errors.
- Its simple geometric interpretation and a sparse solution.
- Like neural networks the computational complexity of SVMs does not depend on the dimensionality of the input space.

Drawbacks of SVM are:

- This classifier involves long training time.
- In SVM it is difficult to understand the learned function (weights).
- The large number of support vectors used from the training set to perform classification task.

The model works by in-taking the image for enhancement. Further the image is segmented for spotting the disease area on leaves and fruits. Later, if the infected area ids highlighted by a yellow border then the plant is said to be effected by bacterial blight else not.

C. Artificial Neural Network (ANN)

An Artificial Neuron is basically an engineering approach of biological neuron .ANN consists of a number of nodes, called neurons. Neural networks are typically organized in layers. It can be carried out as MultiLayer perception (MLP) and Probabilistic Neural Networks (PNNs).

PNN can be accurate than multilayer perception networks also relatively insensitive to outliers. To improve the overall performance PNNs output can be later processed by another classification system and as this happens very fast, PNNs are used in on-line applications where a real - time classifier.

III. PROPOSED APPROACH

The proposed model is efficient in identifying the leaf diseases on plant. The proposed system is using the following methodology to grade disease severity.

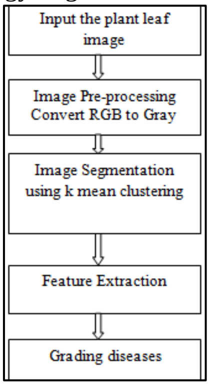

Fig. 1: Modules of the proposed system

IV. IMAGE PRE-PROCESSING

Image processing is the form converting the image into signals. The output of the processed image may be signals, characteristics or parameters which are related to the image. Usage of computerized algorithms to perform the pre-processing task is called digital image processing. Pre-processing involves the techniques such as image resize, filtering, segmentation, cropping, contrast enhancement, angle correction, morphological operations etc. Initially, captured images are resized to a fixed resolution so as to utilize the storage capacity or to reduce the computational burden in the later processing. Noise is inevitable during image acquisition or transmission.

Image Pre-processing Noise gets added during acquisition of leaf images. So different types of filtering techniques are used to remove noise. Create device independent color space transformation structure. Thus create the color transformation structure that defines the color space conversion. The next step is that we apply device-independent color space transformation, which converts the color values in the image to color space specified in the color transformation structure.

The color transformation structure specifies various parameters of transformation. A device independent color space is the one where the resultant color depends on the equipment used to produce it. For example the color produced using pixel with a given RGB values will be altered as brightness and contrast on display device used. Thus the RGB system is a color space that is dependent. To improve the precision of the disease detection and classification process, a device independent color space is required. In device independent color space, the coordinates used to specify the color will produce the same color regardless of the device used to take the pictures.

V. IMAGE SEGMENTATION

Image segmentation is the process of splitting or partitioning of digital images into its constituent regions that help in representing the image easier and meaningful to analyze then before. In the present work the need for segmentation is to partition the image to identify the infected region by the plan disease.

Image segmentation refers to the process of partitioning the digital image into its constituent regions or objects so as to change the representation of the image into something that is more meaningful and easier to analyze. The level to which the partitioning is carried depends on the problem being solved i.e. segmentation should stop when the objects of interest in an application have been isolated. In the current work, the very purpose of segmentation is to identify regions in the image that are likely to qualify as diseased regions. There are various techniques for image segmentation such as clustering methods, compression-based methods, histogram-based methods, region growing methods etc.

K-means clustering method has been used in the present work to carry out segmentation. K-Means Clustering is a method of cluster analysis which aims to partition ‘n’ observations into ‘k’ mutually exclusive clusters in which each observation belongs to the cluster with the nearest mean.

VI. FEATURE EXTRACTION

In the present work the features considered for the process are Colour of the leaf, Texture of the leaf, Shape of the leaf. Among all these colour is the most common feature considered for the extraction. The colour feature can be obtained by various methods like Color histogram, Color correlogram, Color Rmoment, Color structure descriptor. Hence it can be considered as suitable parameter to generate feature vectors which can be further used for classification purpose or for image retrieval.

VII. TYPES OF DISEASES ON PLANT LEAVES

The Plant diseases on the leaves are classified as follows:

A. Viral Disease

Natures of Viruses are very small infectious particles composed of a protein coat and a nucleic acid core. They carry genetic information encoded in their nucleic acid, which typically specifies two or more proteins. Translation of the genome or transcription and takes place within the host cell and uses some of the host's biochemical "machinery".

Symptoms are reduced growth and yellow spotting on leaves, Mosaic pattern of light and dark green (or yellow and green) on the leaves. Malformation of leaves or growing points, Ring-spots or line patterns on leaves, Cup-shaped leaves, etc.

Measures of viral disease are Quarantine Laws, Selection of Seed, Selection of Planting Materials, Eradication, Indexing, etc.

Common diseases are Leaf Curl, Leaf Crumple, Leaf Roll, etc.

B. Fungal Diseases

Nature of Fungi causes damage plants by killing cells and/or causing plant stress. Sources of fungal infections are infected seed, soil, crop debris, nearby crops and weeds. Fungi are spread by wind and water splash, and through the movement of contaminated soil, etc.

Symptoms are White blisters and swellings on leaves, Blackening of roots, Water-soaked rotting of stems and leaves, Softening of plant tissues, Seedlings die or show a reduction in growth.

Measures of fungal disease are Use tolerant varieties, Use clean seed, Monitor weather conditions, Crop rotations, Monitor crops and detect early symptoms.

Common diseases are Anthracnose Black Spot, Tuber diseases, etc.

C. Bacterial Diseases

Nature of Bacterial diseases in plants may affect stems, leaves, roots, or be carried internally without external symptoms. Bacterial infections move from plant to plant quickly, which is why catching the infection early on is important for treatment.

Symptoms are cankers, leaf spots, over growths, Scabs, wilts.

Measures of Bacterial diseases are Use of clean transplants, reduce the pathogen levels by crop rotation, Exclusion or eradication of the pathogen, Understand chemical resistance.

Common diseases are Bacterial Blight Crown Gall, Lint Degradation, etc.

VIII. GRADING USING FUZZY LOGIC

FL, which was first introduced by Lotfi Zadeh (1965), is used to handle uncertainty, ambiguity and vagueness. It provides a means of translating qualitative and imprecise information into quantitative (linguistic) terms. Fuzzy set theory and fuzzy logic provide powerful tools to represent and process human knowledge in the form of fuzzy IF-THEN rules.

Over past few decades fuzzy logic usage has vital growth. Its application area is also wide in range like process control, management and decision making, operations research, pattern recognition and classification. Plants are bound to have diseases. The infected plants are identified and recommended for treatment. To treat these infected plants chemical pesticides are used.

IX. RESULT AND DISCUSSION

Graphical User Interface (GUI) developed using MATLAB is very convenient for experiment. Developed GUI is shown on the Fig.2. GUI contains the appropriate buttons for performing specific actions for detecting the disease. The image for processing is selected from the given dataset. GUI contains the following steps:

1) Select the leaf image
2) Binary of original image
3) K-mean Segmented Image
4) Feature Extraction
5) Binary of Clustered Area
6) Disease Grading
7) Save Image

The input image has to be pre-processed because images are corrupted by a type of multiplicative noise like light intensity and shadow on a cotton leaf images that may contain useful information about the leaf spot that can be used in the diagnosis.

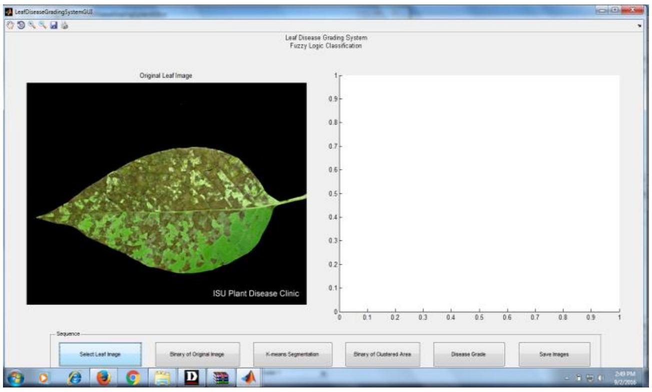

Fig. 2: Anthracnose affected leaf image as input

After the input process the leaf image is converted to binary image this is shown in the Fig.3.

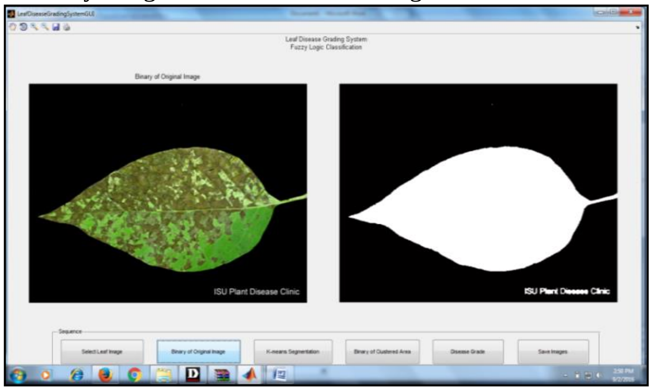

Fig. 3: Conversion of RGB to Gray

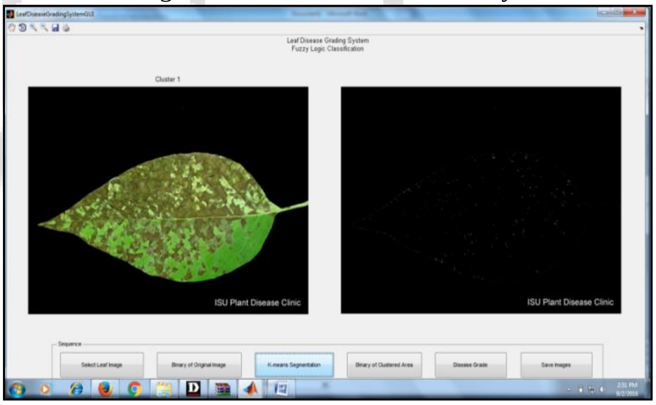

Fig. 4: Segment image of Cluster 1

After the colour converson image, k mean segmentation is used to segment the image. This segmentation process create 5 clusters of images. These cluster images are shown in the following figures such as

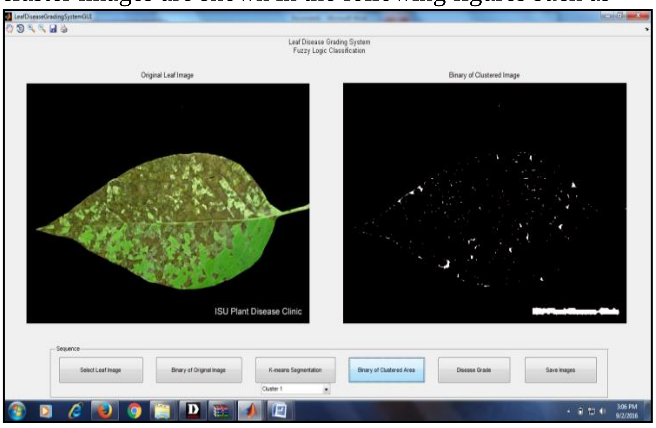

Fig. 5: Segment image of Cluster 2

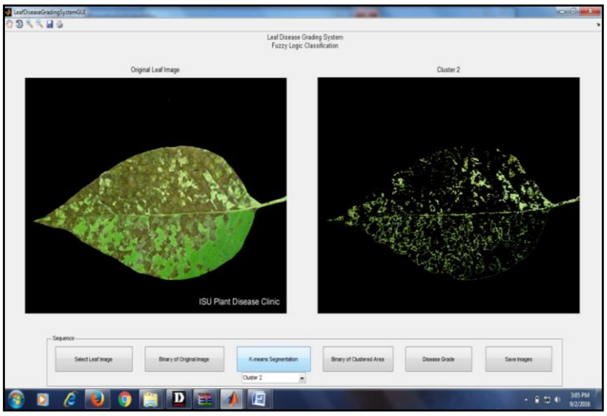

Fig. 6: Segment image of Cluster 3

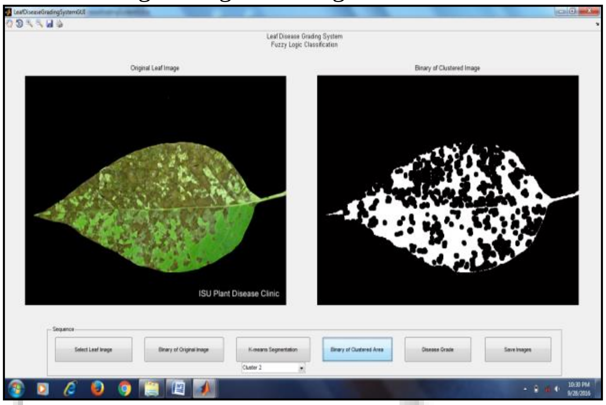

Fig. 7: Segment Image of Cluster 4

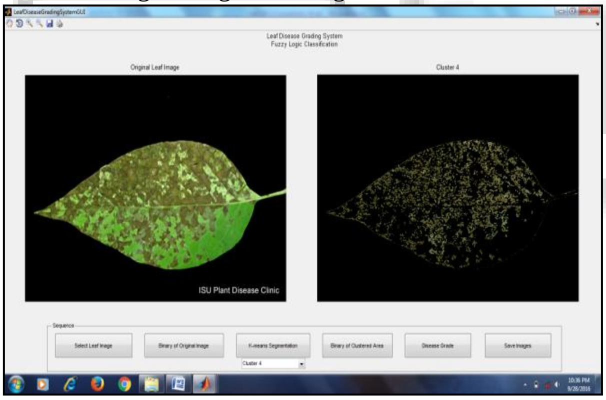

Fig. 8: Binary Image of Cluster 4

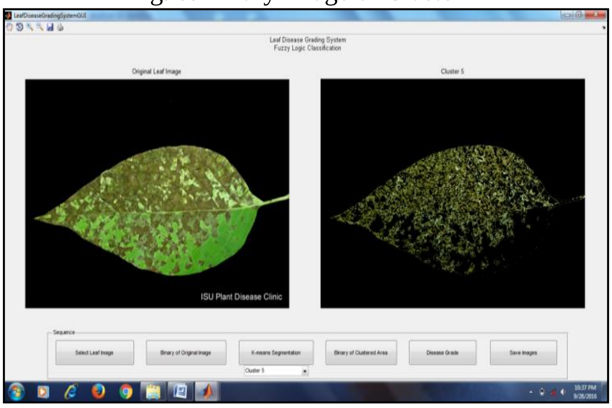

Fig. 9: Binary Image of Cluster 5

After the segmentation 13 features are extracted: Contrast, Correlation, Energy, Homogeneity, Mean, Standard Deviation, Entropy, RMS, Variance, Smoothness, Kurtosis, Skewness, IDM. The values are shown in the Fig.10

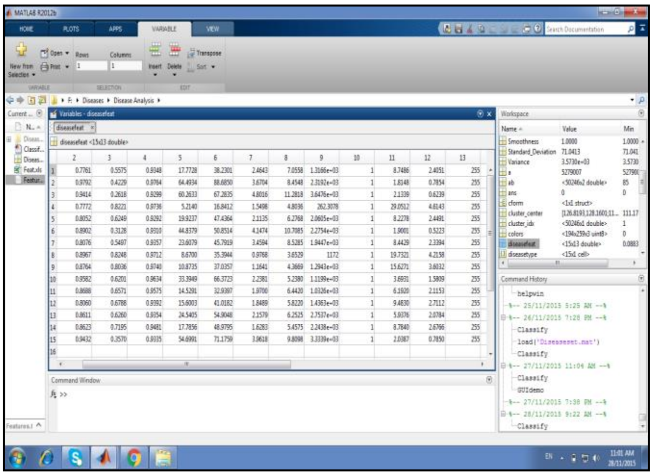

Fig. 10: Values of Features

X. GRADING DISEASE

Once AT and AD are known, the Infected Area(IA) is calculated by applying the formula (1.1).

$$IA = (AD / AT) * 100 \quad (1.1)$$

Using the PI value we can grade the severity of the disease as shown in the Table 1.

Percent Infection Disease	Grade
0	0
0.1-5.999	1
6-15.999	2
16-25.999	3
26-35.999	4
36-45.999	5
46-55.999	6
56-65.999	7
66-75.999	8
76-100	9

Table 1: Disease Scoring Scale for Leaves

Grade of the disease has to be determined from IA. The IA value is shown in the Fig.10 as a graph.

The following figure shows the message with percentage of affected region. In the figure 11 the percentage of affected region is 5.410. According to the table value the grade is 1.

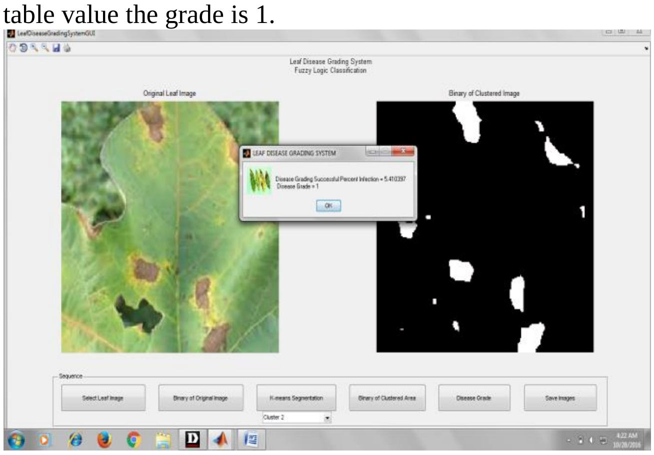

Fig. 11: Diseases Grade is 1

The following Fig.12 shows percentage of infected region as 12.858 with grading 2.

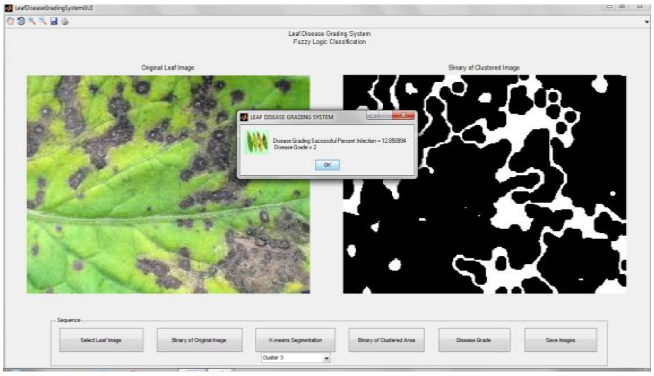

Fig. 12: Diseases Grade is 2

The following Fig.13 shows percentage of infected region as 21.24 with grading 3.

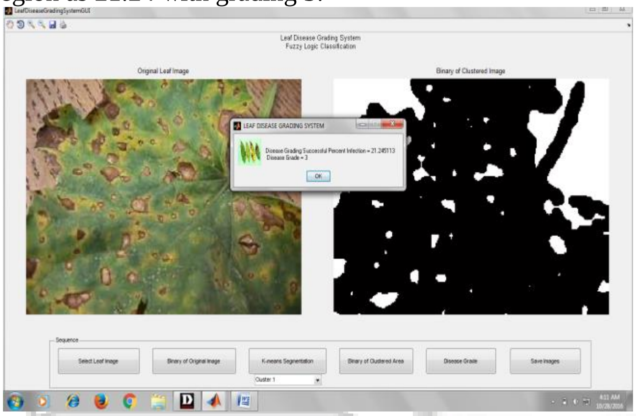

Fig. 13: Disease Grading is 3

The following Fig.14 shows percentage of infected region as 29.194 with grading 4.

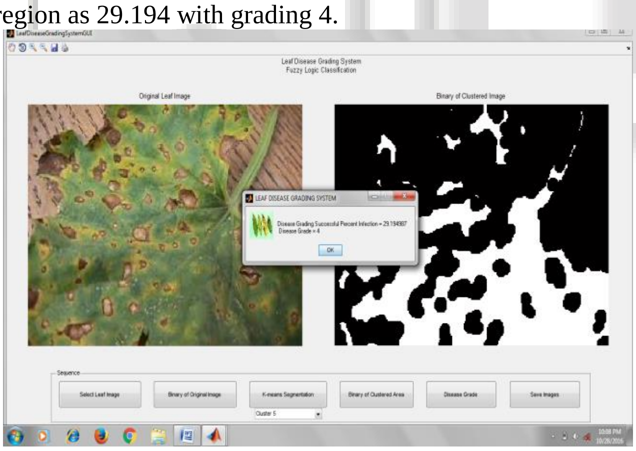

Fig. 14: Disease Grading is 4

XI. Conclusion

The sole purpose of this innovative paper is to improve the efficiency and productivity of the plant disease identification and Grading. This helps in easy spotting of the disease in the infected plant. In future more than five diseases considered for grading to increase the productivity.

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