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Novel Approach of Classification and Detection of Rice Plant Diseases

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Abstract - *In India, Agriculture is traditional and main source of earnings. There are almost 75% of population depends on farming and possesses their abdominal care. Rice is the second most and essential food in India. There are so many varieties and types of rice. This paper represents a survey of different image processing and machine-learning techniques used in the identification and detection of rice plant diseases based on images of disease infected rice plants. Because of these techniques we can prevent rice plants from diseases. Our work is on rice plant diseases and other different plants and fruits, and present a survey of these papers based on important criteria. These criteria include size of image dataset, no. of classes (diseases), preprocessing, segmentation techniques, types of classifiers, accuracy of classifiers etc. We utilize our survey and study to propose and design our work on detection and classification of rice plant diseases. Fungus, bacteria are responsible for disease in the plant.*

Key Words: **Disease classification, Disease detection, Clustering, Support Vector Machine, Image Processing.**

1. INTRODUCTION

In our country there are so many families depends on farming and fulfill their needs from income. Different diseases that occur on rice plants are Leaf -blast, Brown spot, Sheath blight and Leaf scald. Sometimes farmers are unable to pay attention to these diseases or faces difficulties in identifying these type of diseases, which lead to loss of the crop. Every disease has a different remedy to work out. For instance, fungus based disease can be prevented by disrupting the life cycle of the pathogen. The approach of disease detection is manual, which means farmers mainly depend on under the guidance of books or use their experience to identify the diseases. Each plant diseases has different stages of growth. When-ever the disease occurs on a plant, farmers have to keep eyes on the infection. This approach of disease detection is time-consuming and requires some precaution during the selected pesticides. Capturing images of appear infected leaves and getting them processed by an automated system could become an attractive and visual solution for farmer. For instance, an automated system can be deployed in the farm, in which DSLR camera sensors put at different location in the farm captures images regularly and the system processes captured images for an infection. Using such system, farmers can be informed about diseases instantly. This paper focuses on how image processing and machine learning is utilized in detection of diseases in rice plants. The images are captured from the field, the images are preprocessed, the infected parts are extracted from the leaf, then features are extracted from the segmented images, and finally classification of the disease is performed using machine learning techniques.

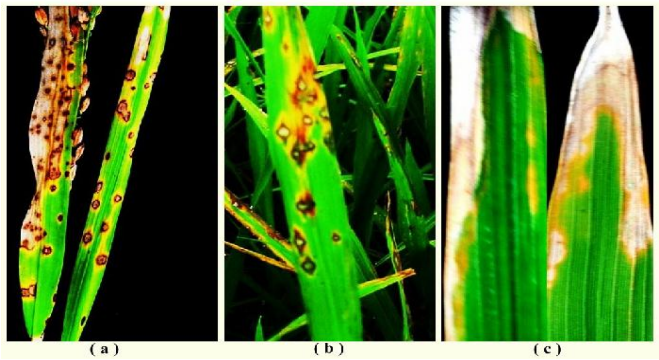

Fig. 1.1: Infected Leaves of Rice Plant

2. RELATED WORK

Different Mechanisms to Detect Plant Leaf Disease Infected Area Parikshit N. Wankhade , Prof. G. G. Chiddarwar presents the study of plant traits/diseases refers to the studies of visually observable patterns of a particular plant. Nowadays crops face many traits/diseases. Damage of the insect to the crop is one of the major trait/disease. Insecticides are not always proved efficient because insecticides may be toxic to some kind of birds.

A Survey on Detection and Classification of Rice Plant Diseases(2016) Jitesh Shah shows identifying disease from the images of the plant is one of the interesting research areas in computer and agriculture field. This paper presents a survey of different image processing and machine-learning techniques used in the identification of rice plant diseases based on images of disease infected rice plants. This paper presents not only survey of various techniques but

also concisely discusses important concepts of image processing and machine learning applied to plant disease detection and classification. These criteria include size of image dataset, no. of classes(diseases), preprocessing, segmentation techniques, type of classifiers, accuracy of classifiers etc. We utilize our survey and study to propose

and design our work on detection and classification of rice plant diseases.

Agricultural Plant Leaf Disease Detection Using Image Processing(2015) Prof. Atul Shire , Prof. Umesh Jawarkar , Mr. Manoj Manmode presents disease management is a challenging task. Huge numbers of disease are seen on leafs or stems of plant. To determine the accurate value of these visually observed diseases has not to learn yet because of the intricacy of visual pattern. In biological science, most of images are produced for using experimental purpose, these images are acquired by digital camera, smart phones etc. Hence to arrange number of experiments on leaf disease detection to extract and analyze content.

Fast and Accurate Detection and Classification of Plant Diseases (2010)

H. Al Hiary, S. Bani Ahmad, M. Reyalat, M. Braik, Z. ALRahamneh The following two steps are added successively after the segmentation phase. In the first step we identify the mostly-green colored pixels. Next, these pixels are masked based on specific threshold values that are computed using Otsu's method, then those mostly green pixels are masked. The other additional step is that the pixels with zeros red, green and blue values and the pixels on the boundaries of the infected cluster (object) were completely removed. The experimental results demonstrate that the proposed technique is a robust technique for the detection of plant leaves diseases. The developed algorithm's efficiency can successfully detect and classify the examined diseases

Plant Disease Detection using Image Processing (2015) represents paper holds a survey on plant leaf diseases classification using image processing. Digital image processing has three basic steps: image processing, analysis and understanding. Image processing contains the preprocessing of the plant leaf as segmentation, color extraction, diseases specific data extraction and filtration of images. Image analysis generally deals with the classification of diseases. Plant leaf can be classified based on their morphological features with the help of various classification techniques such as PCA, SVM, and Neural Network. These classifications can be defined various properties of the plant leaf such as color, intensity, dimensions. Back propagation is most commonly used neural network. It has many learning, training, transfer functions which is used to construct various BP networks. Characteristics features are the performance parameter for image recognition. BP networks shows very good results in classification of the grapes leaf diseases. This paper provides an overview on different image processing techniques along with BP Networks used in leaf disease classification.

Detection of unhealthy region of plant leaves and classification of plant leaf diseases using texture features (2013) S. Arivazhagan, R. Newlin Shebiah, S. Ananthi, S. Vishnu Varthini shows 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 proposed system is a software solution for automatic detection and classification of plant leaf diseases. The developed processing scheme consists of four main steps, first a color transformation structure for the input RGB image is created, then the green pixels are masked and removed using specific threshold value followed by segmentation process, the texture statistics are computed for the useful segments, finally the extracted features are passed through the classifier. The proposed algorithm's efficiency can successfully detect and classify the examined diseases with an accuracy of 94%. Experimental results on a database of about 500 plant leaves confirm the robustness of the proposed approach.

Detection and classification of plant disease using image processing (2013) Niket Amoda, Bharat Jadhav, Pradnya Kurle, Sharon Kunder, Smeeta Naikwadi, aim of this project is to design, implement and evaluate an image processing software based solution for automatic detection and classification of plant leaf disease. However studies show that relying on pure naked-eye observation of experts to detect and classify diseases can be time consuming and expensive, especially in rural areas and developing countries. So we present fast, automatic, cheap and accurate image processing based solution. Solution is composed of four main phases; in the first phase we create a color transformation structure for the RGB leaf image and then, we apply color space transformation for the color transformation structure. Next, in the second phase, the images are segmented using the K-means clustering technique. In the third phase, we calculate the texture features for the segmented infected objects. Finally, in the fourth phase the extracted features are passed through a pre-trained neural network.

Detection and Measurement of Plant Disease Symptoms Using visible-wavelength photography and image analysis (2011) proposes plant disease detection and severity assessment are required for many purposes, including predicting yield loss, monitoring and forecasting epidemics, judging host resistance and for studying fundamental biological host–pathogen processes. If assessments of disease severity are inaccurate and/or imprecise, incorrect conclusions might be drawn and incorrect actions taken. Image analysis based on digital images made using visible wavelengths is one of the several methods used to detect and quantify disease; it offers advantages compared with visual assessment or other methods. Over the last 30 years, major advances have been made to improve reliability, precision and accuracy of image analysis for detecting and measuring plant disease. Although the equipment and software continue to become more sophisticated, these technologies are also becoming easier to use. As a result, image analysis to measure plant disease is becoming increasingly widely used, and has now been applied in the study of numerous plant

diseases. This review describes the history, technology and application of visible-wavelength photography and image analysis, and progress towards realizing the full potential of these systems in plant disease detection and assessment

A Novel Approach for the Detection of Plant Diseases (2016) Sujeet Varshney, Tarun Dalal represents agriculture has become much more than simply a means to feed ever growing populations. It is very important where in more than 70% population depends on agriculture in India. That means it feeds great number of people. Farmers are called the backbone of India. Plants become an important source of energy and only a primary source to the problem of global warming. The damage caused by emerging, re-emerging and endemic pathogens, is important in plant systems and leads to potential loss economically. In addition, crop diseases contribute directly and indirectly to the spread of human infectious diseases and environmental damage. As these diseases are spreading worldwide causing damage to the normal functioning of the plant and also damaging the financial condition by significantly reducing the quantity of crops grown. The crop production losses its quality due to much type diseases and sometimes they occur but are even not visible with naked eyes. Farmers estimate the diseases by their experience but this is not proper way.

A Deterministic Approach for Disease Prediction in Plants using Deep Learning Ramandeep Kaur , Veerpal Kaur proposes this paper details the automatic recognition of diseases & diseased component found in plants leaf picture & also in farming Crop creation. It is completed with development of technology which assists in farming to boom manufacturing. Primarily there's accuracy detection issue in current NN technique. In this research proposal, we have discussed the various advantages and disadvantage of the plant diseases prediction techniques and proposed a novel approach for the detection of diseases.

Disease Detection and Diagnosis on Plant using Image Processing (2015) ,Khushal Khairnar, Rahul Dagade reprents diseases decrease the productivity of plant. Which restrict the growth of plant and quality and quantity of plant also reduces. Image processing is best way for detecting and diagnosis the diseases. In which initially the infected region is found then different features are extracted such as color, texture and shape. Finally classification technique is used for detecting the diseases. There are different feature extraction techniques for extracting the color, texture and edge features such as color space, color histogram, grey level co-occurrence matrix (CCM), Gabor filter, Canny and Sobel edge detector. There are also different classification techniques such as Support Vector Machine (SVM), Artificial Neural Network (ANN), Backpropagation (BP) Network, Probabilistic Neural Network (PNN), Radial Basis Function (RBF) Neural Network.

Design of Monitoring and Control Plant Disease System Based on DSP&FPGA (2010), Chunxia Zhang ; Xiuqing Wang ; Xudong Li proposes a Flash FPGA and a DSP are used in plant disease remote monitoring and control system in this paper. The FPGA is used to acquire and transmit the field plant image or video data for subsequent monitoring and diagnosis, the DSP TMS320DM642 to process and encode video or image data to get high transfer efficiency, the nRF24L01 single chip 2.4GHz radio transceiver is used for wireless data transfer. It has two data compress and transmission tactics to meet users' different need and uses multi-channel wireless communication to lower the whole cost in the system.

Smart Farming: Pomegranate Disease Detection Using Image Processing (2015) Manisha Bhangea, H.A.Hingoliwalab shows crops are being affected by uneven climatic conditions leading to decreased agricultural yield. This affects global agricultural economy. Moreover, condition becomes even worst when the crops are infected by any disease. Also, increasing population burdens farmers to increase yield. This is where modern agricultural techniques and systems are needed to detect and prevent the crops from being effected by different diseases. In this paper, we propose a web based tool that helps farmers for identifying fruit disease by uploading fruit image to the system. The system has an already trained dataset of images for the pomegranate fruit. Input image given by the user undergoes several processing steps to detect the severity of disease by comparing with the trained dataset images. First the image is resized and then its features are extracted on parameters such as color, morphology, and CCV and clustering is done by using k-means algorithm. Next, SVM is used for classification to classify the image as infected or non-infected. An intent search technique is also provided which is very useful to find the user intension. Out of three features extracted we got best results using morphology. Experimental evaluation of the proposed approach is effective and 82% accurate to identify pomegranate disease.

An Approach for Detection and Classification of Fruit Disease: A Survey (2015), Zalak R. Barot1 , Narendrasinh Limbad presents agriculture is the mother of all cultures. It has played an important role in the development of human civilization. Using image Processing can detect degradation in plant/fruit. Plant fruit disease and leaf disease are crucial causes that which reduce quantity and can degrade the quality of the agricultural products. Currently chemicals are applied to the plants periodically without knowing the requirement of plants. There are some common symptoms of plant like color distortion, abnormal leaf growth, shriveled and damaged pods, stunted growth. Although diseases and insect pests can cause considerable yield losses or bring death to plants and it's also directly affect to human health. These require careful diagnosis and timely handling to protect the crops from heavy losses. In plant, diseases can be found in various parts such as fruit, stem and leaves. This paper represents the survey of various approaches for

segmentation method along with feature extraction and classifiers for detection of diseases in fruit and leaf.

Color image segmentation: advances and prospects, H.D. Cheng*, X.H. Jiang, Y. Sun, Jingli Wang presents image segmentation is very essential and critical to image processing and pattern recognition. This survey provides a summary of color image segmentation techniques available now. Basically, color segmentation approaches are based on monochrome segmentation approaches operating in di!erent color spaces. Therefore, we are discuss the major segmentation approaches for segmenting monochrome images: histogram thres-holding, characteristic feature clustering, edge detection, region-based methods, fuzzy techniques, neural networks, etc.; then review some major color representation methods and their advantages/disadvantages; summarize the color image segmentation techniques using different color representations. The usage of color models for image segmentation is also discussed. Some novel approaches such as fuzzy method and physics-based method are investigated as well 2001 Pattern Recognition Society.

Image Processing Approach for Grading And Identification Of Diseases On Pomegranate Fruit: An Overview (2016) D. S. Gaikwad , K. J. Karande , In the present paper introduce an innovative approach to automatically detect and grade the diseases on pomegranate fruit. The diseased pomegranate plant shows specific symptoms colored spots that will occur on the pomegranate fruit. so it is important to monitoring the pomegranate during its growth period and at the time of harvest. The proposed system will be an efficient module that identifies the Bacterial Blight, Cercospora fruit spot, Fruit Rot, Alternaria fruit Spot diseases on pomegranate fruit. In this overview discuss with important issues related to detection of diseases and developing a prime methodology to analyze diseases. Analysis will be done to identify the type of disease and to classify the diseases images into grades depending upon their severity.

An Overview of the Research on Plant Leaves Disease detection using Image Processing Techniques (2014) Ms. Kiran R. Gavhal**,** Prof. Ujwalla Gawande Diseases in plants cause major production and economic losses as well as reduction in both quality and quantity of agricultural products. Now a day's plant diseases detection has received increasing attention in monitoring large field of crops. Farmers experience great difficulties in switching from one disease control policy to another. The naked eye observation of experts is the traditional approach adopted in practice for detection and identification of plant diseases. In this paper we review the need of simple plant leaves disease detection system that would facilitate advancements in agriculture. Early information on crop health and disease detection can facilitate the control of diseases through proper management strategies. This technique will improves productivity of crops. This paper also compares the benefits and limitations of these potential methods. It includes several steps viz. image acquisition, image pre-processing, features extraction and neural network based classification.

A Survey on the Plant Leaf Disease Detection Techniques(2017) Arpita Patel, Mrs. Barkha Joshi Plant disease detection is an interesting field in India a. Plants are the way to live. We are completely dependent on plants from our daily life factors to breathing. So, there should be proper care of plants. Many studies show that quality of agricultural products may be reduced due to various factors. The plant diseases are such as fungi, bacteria, and viruses. The leaf diseases not only restrict the growth of the plant but also destroy its crop. There is the need of some expert to identify plant diseases but manual identification is time consuming. So, some automatic methods required. In this paper, we have presented a survey on the existing methods of plant leaf disease detection.

Plant Disease Detection: a Review of Current Trends, presents awareness of plant leaf diseases is very salient task in agricultural environment. The prior identification of plant leaf diseases can help to prevent the losses that farmers face due to various plant leaf diseases. The plant leaf diseases in image processing are detected by observing the patterns of leaf images at certain period of time. Observation and identification of leaf diseases is not an easy task to do manually because it requires a lot of time, money, effort etc. So it is better to identify the diseases through an automated system in image processing. There are various image processing techniques available for the detection of plant leaf diseases which consists of some basic steps such as, image acquisition, image preprocessing, image segmentation, feature extraction and image classification. Various types of filtering techniques can be used to denoise the image so that the diseases can be detected efficiently and clearly because noise creates problems in identification of diseases. This paper presents a survey on various methods used for detection of plant leaf diseases in image processing. Some segmentation techniques like thresholding, edge based, region based, clustering based and partial differential equation based are discussed.

Leaf Disease Detection and Classification using Neural Networks (2016) V. Ramya1, M. Anthuvan Lydia represents timely and accurate detection and classification of plant diseases are the crucial factors in plant production and the reduction of losses in crop yield. This paper proposes an approach for leaf disease detection and classification on plants using image processing. The algorithm presented has three basic steps: Image Pre-processing and analysis, Feature Extraction and Recognition of plant disease. The plant disease diagnosis is restricted by person's visual capabilities as it is microscopic in nature. Due to optical nature of plant monitoring task, computer visualization methods are adopted in plant disease recognition. The aim is to detect the symptoms of the disease occurred in leaves in an accurate way. Once the captured image is pre-processed, the various properties of the plant leaf such as intensity,

color and size are extracted and sent to SVM classifier with Back propagation Neural Network for classification. The experimental results obtained using 169 images have shown that the classification accuracy by ANN ranges between 88% and 92%.

3. METHODOLOGY

This section presents the proposed work for the rice disease identification. In our proposed system, we intend to detect three rice diseases namely brown spot, bacterial leaf blight, and leaf smut. The block diagram of the proposed work is shown in Fig.3. We discuss the processing steps of our proposed work in following subsections. We also point out the reason for taking a particular decision.

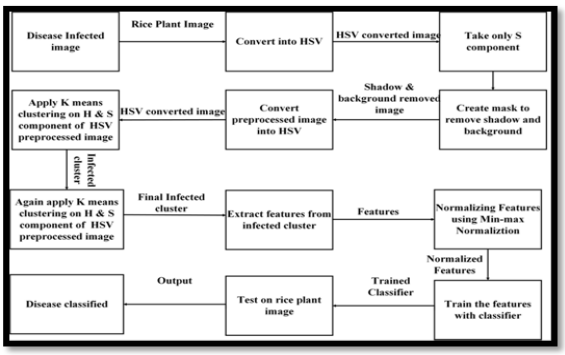

Fig. 3.1: Block Diagram

At each step of plant disease detection, various alternatives are available. Through a detailed study of different literature, we observed that there is no standard or benchmark image dataset available for the research. The authors in [2,7,11,13,23] specify that they created their own image dataset by capturing images from rice fields. After getting the images, image preprocessing is required for preparing images for further processing. Most of the authors [7,21,23] used a median filter to remove or weaken the noise from the images. The median filter is widely used for removing the noise, but in some cases when disease spots are too small, spots get blurred on the application of a median filter. There are also other filters used such as mean filter [13], laplacian filter [11]. Some authors, e.g. in [20], used histogram equalization technique to remove noise. After preprocessing, extraction of disease portion from a leaf is done, which is referred as segmentation. Different techniques available for segmentation are Thresholding [2,12], Otsu's thresholding [7,13,23], Fermi energy based segmentation [3,15], Entropy based bi-level thresholding [14], 8-conncted component labeling [21], and K-means clustering [20]. The next step is feature extraction from disease portion. The widely used features are (1) mean and standard deviation of R, G and B components of diseased portion [3,15,20], (2) area of diseased portion [2,23], (3) texture features such as contrast, uniformity, and linear correlation [23]. The most widely used classifiers in literature are SVM [10,13,20,23], neural network [6,9,11,12], nearest neighbor [2], ensemble learning [10], quadratic discriminant analysis [10], IF-Then classifier [3], Bayes Classifier [13], and Rule Generation [15].

Image Acquisition

We have collected samples of rice plant, both normal and having diseases, from a village called Shertha near Gandhinagar, Gujarat, India. We could get desired leaves of rice plants from the rice field at the start of the winter season in India, in November 2015. We used NIKON D90 Digital SLR camera with 12.3 effective megapixels. We captured images of the leaves on white background, under direct sunlight. We have prepared total 145 images in our database containing 30 images of healthy leaf, 46 images of bacterial leaf blight, 44 images of leaf smut, and 25 images of brown spot. As November was harvesting period for rice crops in Gujarat, we could get only a few hundred leaves.

Image Pre-processing

As shown in Fig. 3, the RGB image is converted into HSV color model. Then, we choose S component of the HSV image because S component does not contain the whiteness. After that, we create a mask such that the mask removes and makes all the background pixels as zeros.

Image Segmentation

K-means clustering is used for the segmentation. Three clusters are expected from the leaf image, background, infected, and (3) green clusters. We apply K-means clustering on the Hue component of the HSV image. For some images, normal K-means algorithm could not produce desired clusters, three segments. To produce accurate segments, we feed the centroid value of each desired cluster, which we find based on histogram analysis of Hue components of the leaf image.

Feature Extraction

Features have crucial role in differentiating one disease from another. We intend to use color features such as mean and standard deviation. We also plan to use texture features such as Kurtosis, skewness, cluster prominence, and cluster shade. For extracting texture features, gray level co-occurrence matrix will be used. Another features that we are empirically exploring are the number of diseased spots and the number of pixels of disease portion falling under 7 pre-defined color ranges.

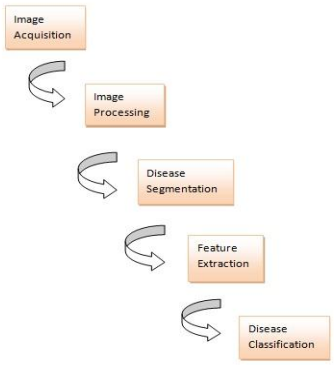

Fig. 3.2: System Diagram

Classification

We will use Support vector machine for the classification. Support vector machine is supervised learning approach. It classifies the training data based on the classes given as training class labels. Linearly separable classes can be identified using a hyper plane while for the data points which are not linearly separable can be handled using kernel function. In our work we have three classes(diseases). We use Gaussian kernel for multiclass classification.

Disease segmentation

We use K-means clustering for image segmentation. Three clusters are expected from a leaf image:

(1) background,

(2) diseased portion, and

(3) green portion. We applied three image segmentation techniques to extract diseased portion from the leaf image:

(1) LAB color space based K-means clustering,

(2) Otsu's segmentation technique, and

(3) HSV color space based K-means clustering.

We use K-means clustering on the Hue component of the HSV image in our proposed work. For some images, normal K-means algorithm could not produce desired clusters, i.e., three segments. To produce accurate segments, we feed the centroid value of each desired cluster, which we find based on histogram analysis of Hue values of leaf portion. We use thresholding to remove the unnecessary green portion present in the diseased cluster, obtained as a result of K-means clustering.

Implementation

This section describes the detailed methodology of our proposed work. We also practically evaluate and discuss different alternatives we explored to arrive at the decision of choosing particular techniques, in our proposed work.

Background removal

The flowchart for removing the background and results of intermediate steps for one sample image .We considered the background of images as white for which we captured the images by putting leaves on a white paper. The disease infected leaf image is converted into HSV color space, refer the second image in Fig. 5. The saturation component of the HSV color space image is extracted, refer the third image in Fig. 5. We are not using hue component for background and shadow removal because hue contains pure color information without any brightness. We observed that shadow pixels do not contain any pure primary colors due to the absence of light in shadow regions. Whereas, the Value component contains lightness. It is only the saturation component that does not contain pure color, brightness, and lightness. After getting saturation component, we convert it in a binary image with a threshold value of 0.28. The binary image has background pixels value zero, while leaf portion has pixel value one. We use this image, as a mask to remove the background. We apply the binary mask on the original image, in RGB color space, to generate the background removed image.

Disease segmentation

To get an accurate diseased portion from a leaf image,we perform enhancement in the result of K-means by feeding centroid values of clusters. Furthermore, we also remove unnecessary green portions (leaf portion) from the disease cluster. Next, we discuss how we carried out segmentation of disease portion. K-means clustering techniques for disease segmentation. We use K-means clustering for extracting the diseased portion from a leaf image. We generated three clusters having diseased portion, non-diseased portion, and background of the image. As LAB color space was used by many researchers for color image segmentation, we first tested rice disease infected images on LAB color space based K-means clustering.

Applied K-means clustering for image segmentation

First, the image with background removal is converted into HSV color space. We applied K-means clustering on the hue component of this image. We have set the value of K = 3. Expected three clusters are

(1) The diseased portion of a leaf,

(2) The non-diseased portion, and

(3) The background.

Matlab function for K-means takes a vector as input. However, we have the hue image, of two dimensions, which is a matrix. Therefore, we reshape the hue component, which

is two-dimensional, using Matlab function reshape() into a vector. The kmeans() function returns the index value of each cluster. This function takes following parameters as input: vector of hue component, the value of K, and initial centroid value for each cluster. We create a labeled image, using reshape() function, having the same size as of original background-removed image by assigning cluster labels to each pixel. We now create three blank images with all pixel values as zeros, i.e., black colors, for storing three output clusters. Then, using labeled image we copy each pixel of an input image to appropriate cluster image. At the end of this step, we get three clustered images.

Removing green regions from disease cluster

We observed that at the end of K-means clustering, the disease cluster contained few green pixels in its surrounding, The unnecessary green portion in the disease cluster can directly affect the accuracy of a classifier because these green pixels adversely contributes in calculations of features. To remove unnecessary green pixels from the disease cluster, we created a binary mask based on these minimum and maximum values of hue component representing the range of green color. We used this mask in morphological operator (opening) to remove small unnecessary portions. However, due to noise present in the image, the image quality gets disturbed, some holes get generated within disease portion. We fill such holes using region filling technique. The result of masking and removing green pixels from the disease portion.

Feature extraction:

We extract three categories of features: color, shape,and texture. We use following features in our work: Color features: We extract following 14 color features of disease portion.

- Mean values of nonzero pixels of R, G, and B components of the diseased portion in an image.
- Mean values of nonzero pixels of H, S, and V components of diseased portion in HSV color space.
- Mean values of nonzero pixels of L, A, and B components of diseased portion in LAB color space.
  - Standard Deviation of nonzero pixels of R, G, and B components of the disease portion of a leaf image.
  - Kurtosis.
  - Skewness.
- Shape features: We extract following 4 shape features of disease portion.
  - Area of diseased portion.
  - The number of disease spots.
  - Minimum area of the obtained diseased spots.
  - Maximum area of the obtained diseased spots.
- Texture features: We extract following 70 texture features of disease portion.
  - Contrast.
  - Correlation.
  - Energy.
  - Homogeneity.
  - Cluster Shade.
  - Cluster Prominence.
  - GLCM properties (contrast, correlation, energy, and homogeneity) in four directions (0, 45, 90, and 135 degrees), i.e., total 16 features = 4 properties, 4 directions.
  - GLCM properties (contrast, correlation, energy,and homogeneity) of HSV components in four directions (0, 45, 90, and 135 degrees), i.e., Total 48 features = 4 properties _ 4 directions_ 3 planes (H, S, and V).

Extraction of color features

First, we extract the R, G, and B components of the image containing only diseased portion and store it into different variables. After that we extract only non-zero values and apply mean2() function of Matlab. The same process was repeated to find the mean values of H, S and V components of the image (in HSV color space) and for L, A, and B components of the image (in LAB color space). We apply std2() function of Matlab on non-zero values of R, G, and B color components.

Extraction of shape features: The total area of the disease portion of a leaf is calculated. It is calculated by converting the segmented image into binary with a threshold of 0.28 using Matlab's inbuilt function im2bw(). This function gives output as a binary image containing 1's and 0's. After that area of binary image is calculated using bwarea() function.

Proportion area = Area of each blob /Total area of all blobs

Extraction of texture features

We use Gray level co-occurrence matrix (GLCM) for extracting the texture features. GLCM contains the number of occurrences of each gray level in the image. Generally, GLCM scans the image in four different directions. We extract features by considering all directions. The Matlab function graycomatrix() was used to create the GLCM. The size of GLC considered is 8 _ 8. Using Matlab function called graycoprops(), we can find the values of all properties of GLCM which are contrast, correlation, energy, and homogeneity. We also calculate cluster shade and cluster prominence.

Classification:

We prepare three classification models based on the number of features chosen. Model 1 consists of 88 features including 70 texture features, 14 color features, and 4 shape features. Model 2 consists of 72 features including 54 texture features, 14 color features, and 4 shape features. Model 3 consists of 40 features including 22 texture features, 14 color features, and 4 shape features.We manually provide labels to each disease, i.e., Bacterial leaf blight = 1, Brown spot = 2, and Leaf smut = 3. We use Support Vector Machine (SVM) to generate three classification models for disease recognition. We use the libsvm library for classification. We use Radial Basis kernel function (Gaussian kernel). This kernel function is generally used for multiclass classification. We also observe the effect of different parameters of SVM such as cost and gamma on the accuracy of our classification models.

- True Positive (TP): It indicates the intersection between the segmented portion and ground truth.
- False Positive (FP): It indicates the segmented parts not overlapping the ground truth.
- False Negative (FN): It indicates missed parts of the ground truth image in the segmented image.
- True Negative (TN): It indicates the part of the image beyond the union of segmentation and ground truth.
- Accuracy: An accuracy of segmentation technique can be calculated by the following equation:

Accuracy = TP + TN / TP + TN + FN + FP

It can be seen that HSV color space based K-means clustering provides highest accuracy among three methods. Therefore, we used this technique in our proposed work for disease segmentation. Therefore, we used this technique in our proposed work for disease segmentation.

4. RESULTS

Initial application is looking like below figure.

Experiment	Accuracy
Contrast	0.2206
Energy	0.7048
Homogeneity	0.9712
Mean	14.3454
Standard_Deviation	38.1658
Entropy	1.7639
RMS	5.1354
Variance	1.2396e+03
Smoothness	1.0000

Table No. 4.1: Results

After extraction of JPEG iamge, we will get output as infected rice plant,

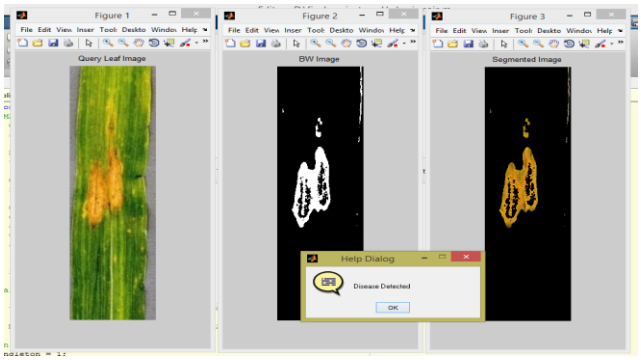

Fig.4.1: Extracted image of rice plant

5. CONCLUSIONS

Rice plant diseases can incur tremendous amount of loss in agriculture if enough attention is not given. Using computer and communication technologies, an automated system can be built which can provide early notification of disease. In the same direction, we tried to provide our contributions in image processing and machine learning aspects of such system. The paper presented detailed schematic diagram of the proposed work and discussed important steps. At present, we are working on completing the implementation of the proposed work. A combination of image processing and machine learning techniques can give opportunities to researchers to address problems in various domains that affect to society directly or indirectly. We used SVM to classify the disease and we achieved 93.33% training accuracy and 73.33% testing accuracy. We also performed k-fold cross validation for k = 5 and k = 10. We also developed easy to use GUI for understanding all intermediate steps performed from image input to disease classification. . Our future work would concentrate on improving the background removal technique, which can work on a real field background. Furthermore, in machine learning part, we intend to apply other classifiers such as rule-based classifier and K-nearest neighbor for classification of rice plant diseases. In future, we would like to improve accuracy on test images. More specifically, accuracy on test images for Leaf Smut was found to be low comparatively. Therefore, we plan to explore other features based on which Leaf smut can be distinguished from Brown spot. In India, in last few years even an ordinary person has started using a smart phone, having Internet connectivity. If this work can be hosted as web-services, its access could become very useful to farmers.

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