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DETECTION OF GRAPE LEAF DISEASE AND ESTIMATION OF VEGETATION INDEX USING IMAGE PROCESSING TECHNIQUE

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Abstract — Plant disease cause large monetary losses in the agricultural products. Productivity of grape decreases due to infections brought via a variety of diseases that infect the fruit, stem and leaves. Hence, it is imperative to detect and become aware of these ailments at the early stages to avoid the losses. This paper focuses on analysing the diseases and carrying out estimation of Vegetation Index for the grape plants. Significant steps comprise of image acquisition, information pre-processing, image segmentation, feature extraction and image classification. Standard classification methods such as Support Vector Machine (SVM) K-Means Clustering algorithm are utilized. Normalized difference vegetation index (NDVI), an essentially parameter which portrays the health/fitness of the is calculated. The calculation process comprises of mathematically comparison of near infrared (NIR) & red- light signals, that can assist in differentiating healthful (green) leaves from dry leaves.

Keywords — Support Vector Machine (SVM), K-Means Clustering, feature extraction, normalized difference vegetation index (NDVI).

1.INTRODUCTION

India is an agricultural country. Seventy percentage of population depends on agriculture. Agricultural is not exclusively to feed the ever-growing population but it's also vital economical source of energy. In India, grape productivity is at the uppermost as compared with other fruits in the world and there is an ample scope to promote it further. Grapes are an essential fruit crop in India. Due to sickness on grape plant, there is loss of about 10-30% of crop. As diseases infecting the leaves are inevitable, detecting the disease plays a vital role in the discipline of agriculture.

Old traditional methods of detecting diseases through naked-eye are not feasible as they will not always be accurate. Some prefer to use insecticides and pesticides to resist these diseases, but using them may harm human health as they may not be used in appropriate quantities. Therefore, there is a need to identify the diseases at the beginning and suggest solutions to the farmers so that maximum harms can be avoided so as to increase the yield. There are lots of techniques in use in order to detect the different diseases of plants in its early stages. Among those techniques, the image processing techniques are becoming very efficient and reliable day by day. To save time, efforts, labours and use of heavy pesticides there is a need of fast and accurate diseases detection of plants. For better quality and quantity of crops in agricultural fields different techniques are proposed by different researchers with the help of digital image processing for rapid and accurate plants disease identification.

This paper focuses on detection of grape leaf disease and estimation of vegetation index using image processing technique. Grapes plant is one of the largely produced crops in India. Improving the productivity of grapes can significantly reduce the food deficiency and can contribute towards improvement in health care. Grapes are crop that are susceptible to many diseases such Black rot, Esca (Black Measles), Leaf blight (Isariopsis_Leaf_Spot) etc. These diseases are caused by fungi which attack on grape leaves as well as berries. Automatic detection of plant diseases is a forthcoming research area as it proves helpful in monitoring large fields, and automatically detects the plant diseases based on the symptoms that are visible on the plant leaves. Therefore, the objective of this paper is to develop image processing technique that can accurately analyse the disease of the grape plants based on images of the leaves, since leaf is a good indicator of the plant health and offer a solution to major national issue of increasing agriculture productivity.

However, there are three diseases which effect on the plants; they are: Black rot, Esca (Black Measles), Leaf blight (Isariopsis_Leaf_Spot). Some real samples of those diseases as shown in Figure 1[1].

(a) (b) (c)

Figure 1: (a) Black rot (b) Esca (Black Measles) (c) Leaf blight

2. LITERATURE REVIEW

Several researchers have done substantial work in crop disease detection. Image Processing is one of the widely used technique is adopted forthe plant leaf diseases detection and classification. However, our brief review is restricted to grapes leaf only.

Meunkaewjinda et al [1] presented automatic grape plant disease diagnosis using manifold artificial smart techniques. The system could establish plant leaf disease without maintaining any knowhow, once the system is trained. Largely, the grape leaf disease is focused in this exertion. The proposed system consists of three foremost fragments: Firstly, grape leaf color segmentation, secondly grape leaf disease segmentation, and thirdly analysis & classification of diseases. The grape leaf color segmentation is pre-processing component which slices out any irrelevant circumstantial information. A self-organizing feature map composed with a back-propagation neural network is installed to recognize colors of grape leaf. This evidence is used to segment grape leaf pixels within the image. Then the grape leaf disease subdivision is performed using modified self-organizing feature map with genetic algorithms for optimization and support vector machines for classification. Finally, the resulting segmented image is filtered by algorithm called Gabor wavelet which consents the system to analyze leaf disease color features more efficient.

Khirade and Patil [2] worked on observing patterns on the grape leaves. They implemented feature extraction and pattern recognition technique to categorize healthy and disease effected leaves. Mainaz et al. [3] recognized the disease on grape leaf using image processing technique. An algorithm was that classified the diseases. Proposed algorithm was tested on three diseases which influence on the Grape plants they are: Black rot, Esca (Black_measles) and Leaf blight (Isariopsis_Leaf_spot). Pranjali and Anjali [4] carried out detection and classification leaf diseases of grape using SVM classification technique. First the diseased region is found using segmentation by K- means clustering. Finally classification technique is used to detect the type of leaf disease.

Rupali et al. [5] carried out survey on different classification techniques that can be used for plant leaf disease classification. A classification technique deals with classifying each pattern in one of the distinct classes. A classification is a technique where leaf is classified based on its different morphological features. Niharika et.al [6], focused their research on developing the different approaches of disease detection and classification for grape plants using ANN.

Shweta Sukumar et.al [7] proposed identification methodology using deep learning method, that differentiated various diseases using basic notion of image processing. Their methodology proposed mainly four stages, viz image acquisition, histogram equalization, GLCM feature and SVM classification.

Wadekar et.al [8] proposed image processing algorithms for grape farming in India. The focus was to detect and provide appropriate pesticides and fungicides to be sprayed on the grape leaves. The major diseases include downy mildew, powdery mildew and anthracnose, which causes every year an enormous economic loss to grape sector. Its effect will diminish the quantity & quality of Grape fruit, as it reduces the photosynthesis process.

Liu et al [9] proposed leaf disease identification using improved deep convolutional neural networks. Miaomiao et al. [10] presented automatic grape leaf diseases identification via United Model based on multiple convolutional neural networks. Jiajun et al. [11] proposed algorithm for black rot disease detection. The technique was based on super-resolution image enhancement and deep learning.

Disease detection on grape leaf is very critical for sustainable agriculture. It is very difficult to continuous monitor the grape disease manually. In this paper, we have tried detection and classification of grape leaf disease using support vector machine (SVM) technique.

3. PROPOSED METHODOLOGY

We have proposed an automated disease detection and classification system for grape leaves using traditional image processing techniques. The proposed system first segments the image using K-means algorithm and classify the segmented leaves as healthy, black rot, esca and leaf blight. These diseases are caused due to fungi infection on the leaves. Each disease have different characteristics where black rot appears to be circular in shape and has dark margins, esca appears as dark red stripes and leaf blight appears to be solid reddish purple spots.

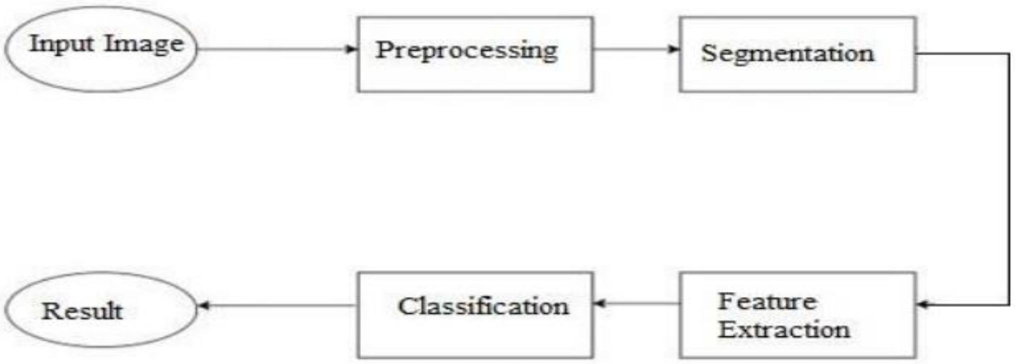

Figure 2: System Design

The proposed system consists of five different process such as input image, image preprocessing, image segmentation, feature extraction, classification.

Black rot Esca Leaf Blight Healthy

Figure 3: Different types of disease in Grape Leaves

The overall flow of the proposed system is depicted in the Figure .2.

3.1 Input image:

In this step the sample images are collected, which is required to train the system. In this study, image are collected from different regions. Few of the images have been taken from internet. The standard .jpg format is used to store these images. The Collected images include the leaves infected by Black rot,Esca_(Black_measles), Leaf_Blight_(Isariopsis_leaf_spot) and the Healthy leaf.

3.2 Image processing:

The image pre-processing is done on gathered images for improving the image quality. There are three steps of image processing, i.e., image resizing, image colour transforming and image background subtracting.

i. Image Resizing:

The images are resized to achieve uniformity in terms of image and its size. The original images are bigger, due to which it takes a long time to process. Hence images are resized into small sizes to avoid time consumption. We convert the input RGB image into HSV (Hue Saturation Value) format using rgb2hsv command.

ii. Image Colour Transformation:

The input "RGB images" are converted to "Hue Saturation Value" (HSV) colour space and this conversion is called a colour transformation. After transformation, the Hue component is generally considered for further process. As it is the dominant colour and does not consider the saturation and intensity component because it doesn't provide any helpful information. The colour spaces represented by greyscale images.

iii. Image Background Subtraction:

To remove undesired backgrounds from the images and to extract the required region of the image, "background subtraction" techniques are adopted. Colour based background subtraction techniques are used for achieving more accuracy. In this technique, based on RGB intensity values, unwanted backgrounds are removed. As green coloured pixels consist of healthy parts, only these are kept as it is whereas the other pixels are coloured black.

3.3 Image Segmentation:

Image segmentation divides the images into smaller subgroups of images or pixels to reduce the complexity of images, and image analysis can be done easily. The splitting and grouping of pixels to form a sub-image can be done using various image segmentation algorithms. The segmentation technique used is colour segmentation which follows the colour features and a saliency method extracting only valuable objects from the image and discarding the rest. The segmentation based on K-means technique is a partition clustering technique used to partition n number of observations into k clusters. In this technique, k is the number of clusters in the segmented image and colours present in an image are used for the clustering.

3.4 Feature Extraction:

The creation of a collection of features from the raw data provided initially is known as feature extraction. The data that is being dealt with in the modern-day consists of data with enormous amounts of features. If the number of features available becomes as big as the data considered or even reaches numbers beyond the data considered, this may lead to a machine learning model suffering from model-overfitting. Feature extraction can generally be viewed as a method provided that can get around major problems yet describe the data efficiently. Most of the papers considered adopt techniques to extract various features such as shape, colour and texture features.

3.5 Classification:

Classification comprises of training and testing processes, where features extracted from training leaves are compared with those extracted from testing leaves. The image is then classified based on the matched features. Image acquisition, segmentation and feature extraction comes under the training process and classification comes under the testing process. Image classification is the final step in which results are classifying the Grapes leaves into different disease classes. There are usually three diseases which effect on the plants; they are: Black rot, Esca_(Black_Measles), Leaf_blight_(Isariopsis_Leaf_Spot).

3.6 NDVI:

Normalized Difference Vegetation Index (NDVI) is an arithmetic indicator that is used for a perceptible and infrared band of electromagnetic gamut. NDVI, principally is calculation of crop/leaf health or vegetation. Mathematically linking Near Infrared (NIR) and Red light signals. That can support to discern healthy leaves from dead/dry leaves.

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

Basically, it works by mathematically comparing the amount of absorbed visible red light and the reflected near-infrared light. And the reason for the same are discussed below. The chlorophyll pigment in a healthy plant absorbs most of the visible red light, while the cell structure of a plant reflects most of the near-infrared light. It means that high photosynthetic activity, commonly associated with dense vegetation, will have fewer reflectance in the red band and higher reflectance in the near-infrared one. By looking at how these values compare to each other, one can consistently perceive and analyse vegetation cover separately from supplementary types of natural land cover.

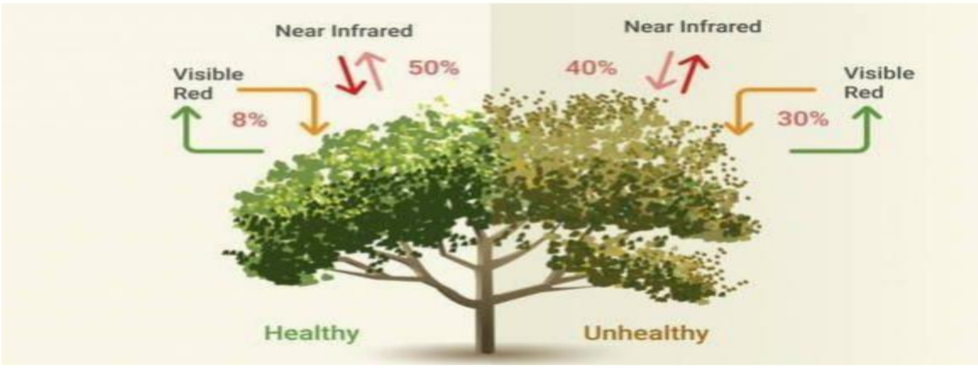

Figure 4: Working of NDVI

4. RESULTS

For the experimental work, a database of 400 images is created. The RGB image is pre-processed with colour transformation and background withdrawal and then segmented with k-means clustering procedure which segments the image into 4 clusters. From the image colour, shape and texture features were extracted. From these topographies, support vector machine (SVM) is trained and it helps to segregate the images into different classes as healthy and diseased which supplementary categories various ailments such as as black rot, Esca (Black Measles), Leaf blight.

For investigation purpose, the database is organized into two sets: the exercise and the testing set. Different training testing fractions are taken into consideration to find out the exactness of the classifier. The classifiers used for assessment are Support vector machine (SVM). The middling accuracy of the proposed method comes to be around 91%.

Normalized Difference Vegetation Index (NDVI) is a numerical pointer that is used for a visible and infrared band of electromagnetic gamut. NDVI, basically is calculation of crop/leaf health or vegetation. Mathematically associating Near Infrared (NIR) and Red light signals. That can help to differentiate healthy leaves from dead/dry leaves.

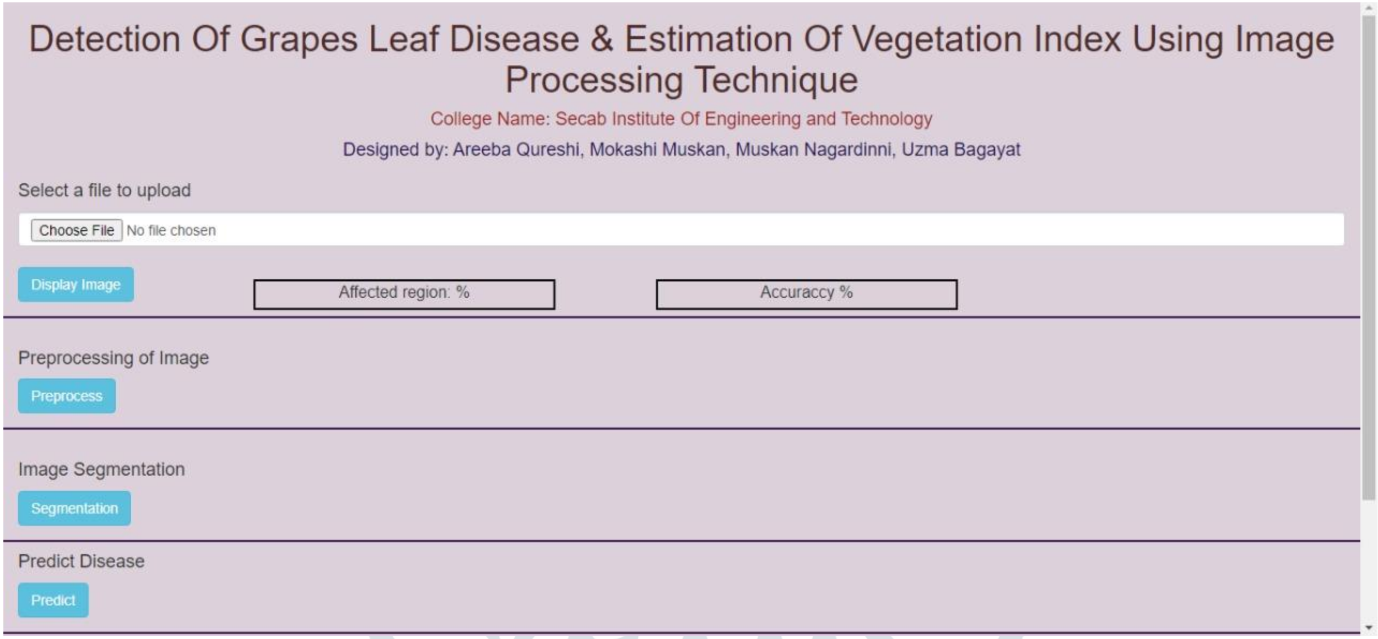

Figure 5: GUI Front end of the Software

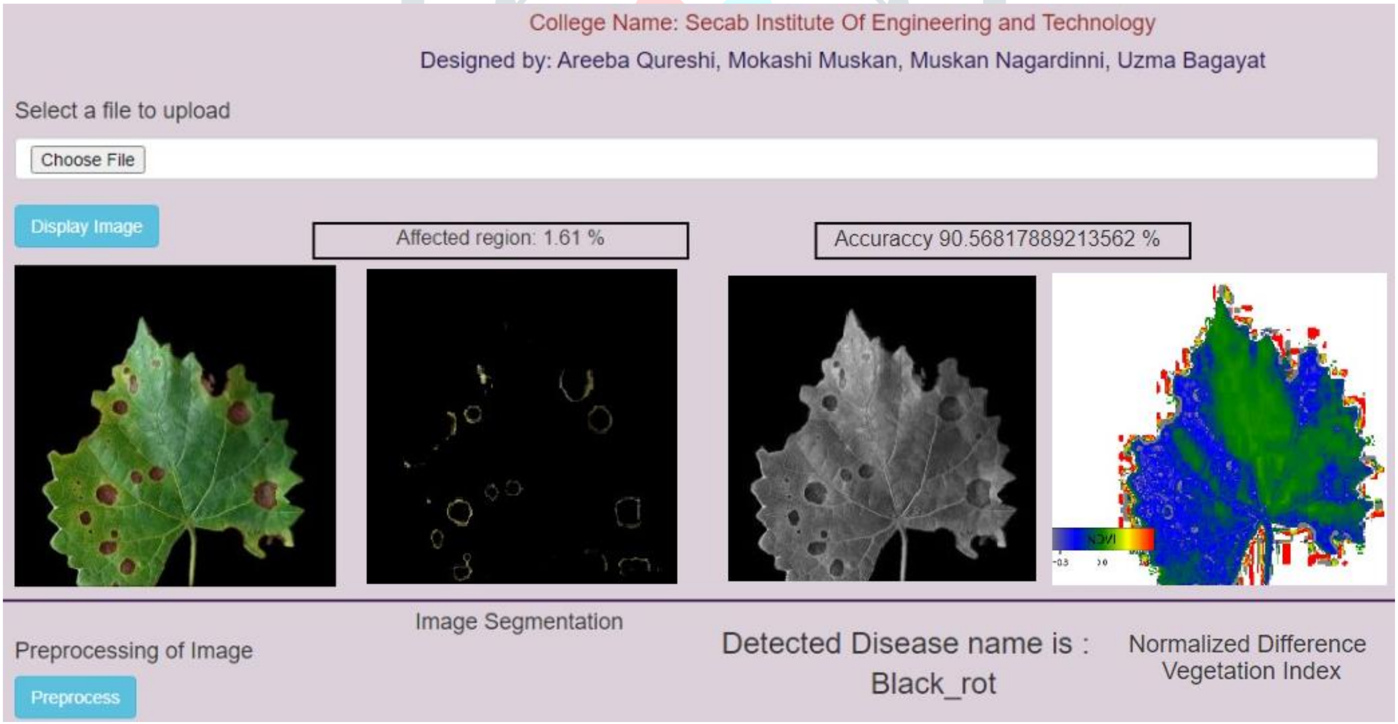

Figure 6: Output (Detection of Disease)

Calculations:

$$NDVI = \frac{NIR - Red}{NIR + Red} \qquad NDVI = \frac{0.4 - 0.30}{0.4 + 0.30} = 0.14$$

Normalized Difference Vegetation Index (NDVI) is an imaging processing product that quantifies vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs) Green plants reflect much of the near infrared light and very little of the red light, while brown plants reflect more red light and less near infrared light. By taking the ratio of red and near infrared reflectance an index of vegetation: greenness" can be defined; a low NDVI value indicates the plant is brown, while a high NDVI value indicates the plant is green. NDVI value ranges from -1 to 1. NDVI value of -1 to 0 indicates a dead plant orobject, 0-0.33 value indicates unhealthy plant, 0.33-0.66 value indicates moderately healthyplant, 0.66-1 value indicates very healthy plant.

5. CONCLUSION

Recognizing the disease is mainly the purpose of the proposed approach. Thus, the proposed Algorithm was tested on three diseases which influence on the Grape plants they are: Black rot, Esca (Black measles), Leaf blight (Isariopsis_Leaf_spot). The experimental results indicate that the proposed approach is a valuable approach, which can significantly provide an accuracy of 90.56% for detection of leaf diseases.

6. FUTURE ENHANCEMENTS

The future work comprises incorporating stem, fruit and root-based image processing analysis. The proposed work can be extended to various agricultural crops. Every year the loss due to various diseases is challenging part in agriculture production. Although work iscarried out till time on detection of diseases but proper segmentation of affected part basedon type of plant family is still an open problem as a research area. One other future implementation could be the system could be made real time operating system. Future expansion of this work will be focused on following points:

1) To develop combinations of more algorithms by using fusion classification technique,so as to improve the detection rate of the classification process.

2) On the basis of detection of disease the proper mixture of fungicides will be provided tothe grape farmer for further use in their farms.

3) To design an automated system with the help of embedded system so that this fungicide mixture will be automatically sprayed using spraying mechanism.

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