Fuzzy Logic and Computer Vision Techniques to Detect Plant Disease Using Image Processing

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Abstract—**Identification of the plant diseases is the key to preventing the losses in the yield and quantity of the agricultural product. The studies of the plant diseases mean the studies of visually observable patterns seen on the plant. Health monitoring and disease detection on plant is very critical for sustainable agriculture. It is very difficult to monitor the plant diseases manually. It requires tremendous amount of work, expertize in the plant diseases, and also require the excessive processing time. Hence, image processing is used for the detection of plant diseases. Disease detection involves the steps like image acquisition, image pre-processing, image segmentation, feature extraction and classification. This paper discussed the methods used for the detection of plant diseases using their leaves images. This paper also discussed some segmentation and feature extraction algorithm used in the plant disease detection. Keywords – Image acquisition, Segmentation, feature extraction**

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I. INTRODUCTION

The 2 papers referred are:

1. Orchid Disease Detection Using Image Processing and Fuzzy Logic Muhammad Thaqif bin MohamadAzmi Faculty of Electrical Engineering Universiti Teknologi MARA 40450 Shah Alam, Selangor Naimah Mat Isa Faculty of Electrical Engineering Universiti Teknologi MARA 40450 Shah Alam, Selangor(https://ieeexplore.ieee.org/abstract/document/6895039)
2. Plant Disease Detection Using Image Processing Sachin D. Khirade M.E Student (Electronics & Telecommunication Engg.) Pimpri Chinchwad College of Engg. Savitribai Phule PuneUniversity Pune, India sachin.khirade@gmail.com (https://ieeexplore.ieee.org/abstract/document/7155951)

A plant disease is condition caused by infectious organisms or environmental factor. This condition is being studied in a scientific field called the Plant Pathology. The organisms that can cause this disease include fungi, bacteria and virus. There can also be parasites like insects and mites that eat the plant tissues resulting in diseased parts. There are many ways to detect a plant disease like looking at its physiology (root, twig or leaf) or by taking a sample and test it using chemical substance. However it is easier to just check its physiology. One of the parts that can be checked is the leaf. The leaf is one of the usual places that show the disease's symptoms due to its importance in nutrient supplying in plants. When a plant is infected the disease is propagated throughout the plant using its nutrient route and since leaves are one of the sources of plant nutrients it is one of the most affected part of plant. Figure 1 shows that some of the leaf is attacked by disease. The disease can be determined by looking at the leaf abnormal parts. Abnormal parts here mean the black spots or the yellowing parts of a leaf. One can also check the texture of a leaf whether it is harder or softer than what it should be. Human eye can perceive and process these properties and determine whether the plant is sick or not. However, a machine needs a complicated algorithm and data classification in order to determine if a plant is diseased. Image processing has been done for many years. Many new algorithms and technologies are discovered every year to solve image processing problem [1]. Image processing is usually run by a computer due to the large number of data to be processed. This is because each color is numbered in order for a computer to process it and a modern picture can have more than two hundred million colors (the number of color in a visible spectrum). However, only super computer can truly process a fully colored picture. Many of the algorithms incorporate changing the image into black and white for simpler processing. Even then, most of the algorithms have difficulty processing images in a noisy environment [2][3]. Edge detection is one of the most often used when doing an image processing system. This is because even in human perception, the easiest thing to perceive is the edge of an object [6]. From perceiving the edge it is possible to know the shape and size of the object. Texture detection is also one of the often used algorithms. With this algorithm one can differ between two or more surfaces that have different textures. This paper uses a number of algorithms in order to process the images of the leaf.

II. DATASETS

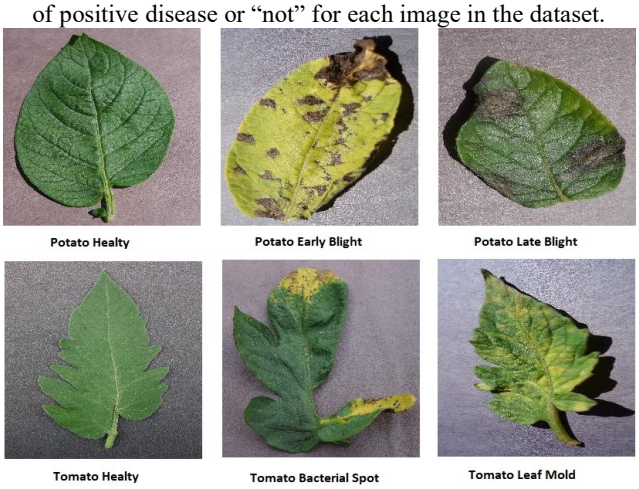
Data Acquisition: The data here means the pictures used for image processing. Three different types of orchid leaves with diseases are used. A total number of 80 pictures were taken.

The pictures were captured using a camera with fixed conditions. Table 1 shows the conditions that the pictures were taken in. Figure 3 shows an example of picture taken.

1. https://www.kaggle.com/vipoooool/new-plant-diseases-dataset
2. https://www.kaggle.com/c/plant-pathology-2020-fgvc7

III. INPUTS

All images have been collected in one dataset and loaded for scaling at a fixed size of 224 X 224 pixels to be suitable for further processing within the fuzzy pipeline. One-hot encoding is then applied on the labels of image data to indicate the case of positive disease or "not" for each image in the dataset.



IV. TOOLS USED

- Tested with Tensorflow 1.13 and 1.15
- OpenCV 4.2.0
- Python 3.6
- Numpy
- Scikit-Learn
- Matplotlib

Additional requirements to generate dataset:

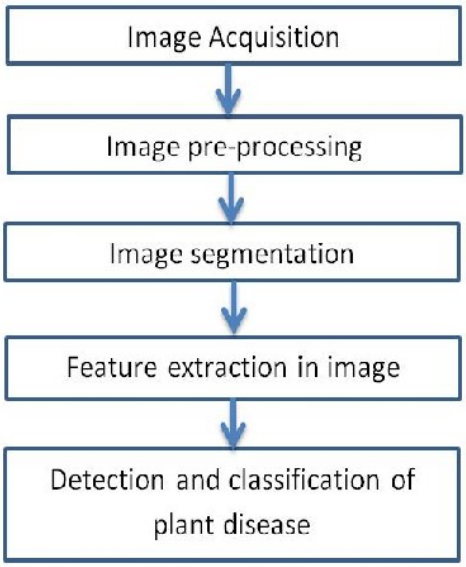
- PyDicom
- Pandas
- Jupyter

V. PROPOSED METHODOLOGY

In this section, the basic steps for plant disease detection and classification using image processing are shown (Fig. 1)). Fig. 1)
Basic steps for plant disease detection and classification

A] Image Acquisition The images of the plant leaf are captured through the camera. This image is in RGB (Red, Green And Blue) form. color transformation structure for the RGB leaf image is created, and then, a device-independent color space transformation for the color transformation structure is applied [6].

B] Image Pre-processing To remove noise in image or other object removal, different pre-processing techniques is considered. Image clipping i.e. cropping of the leaf image to get the interested image region. Image smoothing is done using the smoothing filter. Image enhancement is carried out for increasing the contrast. the RGB images into the grey images using colour conversion using equation (1). f(x)=0.2989*R + 0.5870*G + 0.114.*B - - - - - - - - - - - - - (1) Then the histogram equalization which distributes the intensities of the images is applied on the image to enhance the plant disease images. The cumulative distribution function is used to distribute intensity values [2].



C] Image Segmentation Segmentation means partitioning of image into various part of same features or having some similarity. The segmentation can be done using various methods like otsu' method, k-means clustering, converting RGB image into HIS model etc.

1] Segmentation using Boundary and spot detection algorithm: The RGB image is converted into the HIS model for segmenting. Boundary detection and spot detection helps to find the infected part of the leaf as discussed in [9]. For boundary detection the 8 connectivity of pixels is consider and boundary detection algorithm is applied [9].

2] K-means clustering: The K-means clustering is used for classification of object based on a set of features into K number of classes. The classification of object is done by minimizing the sum of the squares of the distance between the object and the

corresponding cluster. The algorithm for K –means Clustering: 1. Pick center of K cluster, either randomly or based on some heuristic. 2. Assign each pixel in the image to the cluster that minimizes the distance between the pixel and the cluster center. 3. Again compute the cluster centers by averaging all of the pixels in the cluster. Repeat steps 2 and 3 until convergence is attained.

3] Otsu Threshold Algorithm: Thresholding creates binary images from grey-level images by setting all pixels below some threshold to zero and all pixels above that threshold to one. The Otsu algorithm defined in [5] is as follows:
i) According to the threshold, Separate pixels into two clusters
ii) Then find the mean of each cluster.
iii) Square the difference between the means.
iv) Multiply the number of pixels in one cluster times the number in the other 769 The infected leaf shows the symptoms of the disease by changing the color of the leaf. Hence the greenness of the leaves can be used for the detection of the infected portion of the leaf. The R, G and B component are extracted from the image. The threshold is calculated using the Otsu's method. Then the green pixels is masked and removed if the green pixel intensities are less than the computed threshold.

D] Feature Extraction Feature extraction plays an important role for identification of an object. In many application of image processing feature extraction is used. Color, texture, morphology, edges etc. are the features which can be used in plant disease detection. In paper [3], Monica jhuria et al considers color, texture and morphology as a feature for disease detection. They have found that morphological result gives better result than the other features. Texture means how the colour is distributed in the image, the roughness, hardness of the image. It can also be used for the detection of infected plant areas.

VI. OUTPUTS

The output of the fuzzy logic system is whether or not the leaf in question is healthy (0) or sick (1). By looking at table 3, it can be inferred that the leaves in question are sick to a degree. All three defuzzification methods show that the leaves are at least a little bit diseased even though the MoM method may not be suitable because of its one-patterned result.

VII. CONCLUSIONS

The accurately detection and classification of the plant disease is very important for the successful cultivation of crop and this can be done using image processing. This paper discussed various techniques to segment the disease part of the plant. This paper also discussed some Feature extraction and classification techniques to extract the features of infected leaf and the classification of plant diseases. The use of ANN methods for classification of disease in plants such as self organizing feature map, back propagation algorithm, SVMs etc. can be efficiently used. From these methods, we can accurately identify and classify various plant diseases using image processing techniques.

Table 3: Output using 3 different methods

Input		Output		
LeafArea (M Pix)	SpotNum (K Pix)	CoM	MoM	CoA
1.737	0.630	0.598	0.875	0.560
1.365	1.383	0.875	0.875	0.729
0.977	0.264	0.336	0.125	0.399
1.679	0.569	0.552	0.875	0.532
1.503	1.669	0.875	0.875	0.729
1.156	0.296	0.399	0.125	0.439
1.122	0.512	0.506	0.875	0.504
1.480	1.730	0.875	0.875	0.729
0.859	0.341	0.419	0.125	0.450
1.968	0.838	0.754	0.875	0.655

VIII.REFERENCES

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