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Proposed Fungi Disease Detection Method for Vegetable Crops using Image Processing

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Abstract: Agriculture plays the major role as it is big economic sector. However productivity of farm reduces by the plant diseases. Quality and quantity of plants also affected due to Different plant diseases, So Early detection plays vital role, to minimize the damage from plant diseases. The manual method for plant disease detection is poor, time consuming, uncertain and costly .Plant diseases are caused by bacteria, fungi and viruses. Fungal disease leads to sever damage to plant quality and productivity. There is fair amount of scope for plant disease detection in the area of agriculture. The recent computer vision and image processing based methods are quite primitive. Efficient image processing based method targeting towards better accuracy is a need of hour. Reliable, Robust and scalability factors needs to be considered while designing method for detecting plant diseases. Fungi disease detection of the leafy vegetables is first motivation of this research. Improving disease detection accuracy using optimized image processing algorithms. Along with leaf disease detection, crop detection and grading of disease is also important for automated system.

Keywords: Leaf disease, Image Processing, Segmentation, Feature Extraction, Classifiers

I. INTRODUCTION

As we know in India approximately 70 % population depends on the agriculture as India is cultivated country. Farmers have large range of diversity for selecting various suitable crops and finding the suitable pesticides for plant. Disease on plant leads to the significant reduction in both the quality and quantity of agricultural products. The studies of plant disease refer to the studies of visually observable patterns on the leafy vegetables. Monitoring of health and disease on plant plays an important role in successful cultivation of crops in the farm. In early days, the monitoring and analysis of plant diseases were done manually by the expertise person in that field. This requires tremendous amount of work and also requires excessive processing time. The image processing techniques can be used in the plant disease detection. In most of the cases disease symptoms are seen on the leaves, stem and fruit. The plant leaf for the detection of disease is considered which shows the disease symptoms. Disease fungi take their energy from the leafy vegetables on which they live. They are responsible for a great deal of damage and are characterized by wilting, scabs, moldy coatings, rusts, blotches, and rotted tissue. Fungi disease detection from the leafy vegetables is first motivation of this research. There are number of image processing based techniques already introduced for fungi disease detection from the different crops, but they have concern on accuracy of detection, robustness of detection and efficiency. The existing methods are having the limited scope on detection. This becomes another motivation for this research. Along with leaf disease detection for crops, crop detection and grading of disease is also important for automated system. To our knowledge, there is no system proposed so far for automatic crop detection and then disease grading for that crop leaf disease detected. This becomes our last motivation. Plant diseases are caused by bacteria, fungi, virus, nematodes, etc., of which fungi are responsible for a large number of disease symptoms in leafy vegetables [3]. Figure 1 is showing the different fungi diss.

A. Fungal Disease B. Bacterial Disease

Figure 1: Example of Fungi Diseases on Crops

In this research, we are presenting the robust and efficient framework for automatic detection and grading of diseases like fungi, bacterial etc. on crop like vegetables, additionally, crop identification is also important for proper treatment of disease affected leafy vegetables, hence we are designing method for crop identification as well. The proposed methodology designing is base on image processing terminologies such as pre-processing, segmentation, feature extraction and classification.
Below are main objectives of this research work

- To study existing solutions for leafy vegetable disease identification and grading based on image processing technologies.
- To design image segmentation algorithm based on improved region growing method for leafy vegetable crops.
- To design feature extraction algorithms by contributing the hybrid feature extraction techniques
- To design ANN based Novel classification method for leafy vegetable disease detection and grading
- To evaluate the performance in terms of accuracy, precision, recall and processing time.
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II. PROPOSED METHODOLOGY

As the goal of this paper is to present automated computer aided diagnosis framework based on image processing for early fungi disease detection caused on leafy vegetables and disease grading with crop identification. Table 1 is giving the information on core contribution and methodologies for this research work. Below listed are three main contribution of this thesis work.

Table 1: Methodologies

Number	Methodologies
Contribution 1	Data collection and pre-processing using combination of filters.
Contribution 2	Efficient Segmentation using improved region growing method.
Contribution 3.1	Feature extraction efficient algorithms by contributing the hybrid feature extraction techniques.
Contribution 3.2	Novel classification method for crop disease detection and grading

As showing above table, three novel methods proposed in this thesis in order to overcome the research challenges of existing automated methods of plant disease identification and grading.

DATASET COLLECTION

Vegetable Crops
The disease initiates at back of the leaves and it spreads to other parts of the leaves. We will collect the images of different types of leafy vegetable crops for both normal and disease affected leafs for this research work.

5.3. Features: In feature extraction section, below listed features will be considered.

A. Texture Features
Texture feature extraction is very robust technique for a large image which contains a repetitive region. The texture is a group of pixel that has certain characterize. The texture feature methods are classified into two categories: spatial texture feature extraction and spectral texture feature extraction.

B. Mean
The mean, m of the pixel values in the defined window, estimates the value in the image in which central clustering occurs. The mean can be calculated using the formula:

$$\mu = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N} p(i,j) \quad \ldots\ldots\ldots\ldots.. (1)$$

Where p(i,j) is the pixel value at point (i,j) of an image of size MxN.

C. Standard Deviation
The Standard Deviation, σ is the estimate of the mean square deviation of grey pixel value p (i,j) from its mean value. Standard deviation describes the dispersion within a local region. It is determined using the formula:

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$$\sigma = \sqrt{\frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(p(i,j)-\mu)^2} \quad \text{…………..} (2)$$

D. Smoothness

Relative smoothness, *R* is a measure of grey level contrast that can be used to establish descriptors of relative smoothness. The smoothness is determined using the formula:

$$R = 1 - \frac{1}{1+\sigma^2} \quad \text{…………..} (3)$$

Where, σ is the Standard Deviation of the image.

E. Entropy

Entropy is a statistical measure of randomness that can be used to characterize the texture of the input image. Entropy, h can also be used to describe the distribution variation in a region. Overall Entropy of the image can be calculated as:

$$h = -\sum_{k=0}^{L-1} Pr_k(log_2 Pr_k) \quad \text{…………..} (4)$$

Where, Pr is the probability of the k-th grey level, which can be calculated as Zk /m*n, Zk is the total number of pixels with the kth grey level and L is the total number of grey levels.

F. Skewness

Skewness, S characterizes the degree of asymmetry of a pixel distribution in the specified window around its mean. Skewness is a pure number that characterizes only the shape of the distribution. The formula for finding Skewness is given in the below equation:

$$S = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left(\frac{p(i,j)-\mu}{\sigma}\right)^3 \quad \text{…………..} (5)$$

Where, p(i, j) is the pixel value at point (i,j), m and σ are the mean and standard deviation respectively.

G. Kurtosis

Kurtosis, K measures the Peakness or flatness of a distribution relative to a normal distribution. The conventional definition of kurtosis is:

$$K = \left\{\frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left[\frac{p(i,j)-\mu}{\sigma}\right]^4\right\} - 3 \quad \text{…………..} (6)$$

Where, p(i,j) is the pixel value at point *(i,j),* m and σ are the Mean and Standard Deviation respectively. The -3 term makes the value zero for a normal distribution.

H. Root Mean Square (RMS)

The RMS (Root Mean Square) computes the RMS value of each row or column of the input, along vectors of a specified dimension of the input, or of the entire input. The RMS value of the jth column of an M-by-N input matrix u is given by below equation:

$$y = \sqrt{\frac{\sum_{i=1}^{M}|u_{ij}|^2}{M}} \quad \text{…………..} (7)$$

I. Inverse Difference Moment (IDM)

It is a measure of image texture. IDM ranges from 0.0 for an image that is highly textured to 1.0 for an image that is untextured. The formula for finding the IDM is given in below equation:

$$H = \sum_{i,j}\frac{P(i,j)}{1+|i-j|} \quad \text{…………..} (8)$$

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J. Energy
Energy returns the sum of squared elements in the Grey Level Co-Occurrence Matrix (GLCM). Energy is also known as uniformity. The range of energy is [0 1]. Energy is 1 for a constant image. The formula for finding energy is given in below equation:

$$E = \sum_{i,j} P(i,j)^2 \quad \ldots\ldots\ldots\ldots (9)$$

K. Contrast
Contrast returns a measure of the intensity contrast between a pixel and its neighbour over the whole image. The range of Contrast is [0 (size (GLCM, 1)-1) ^2]. Contrast is 0 for a constant image. Contrast is calculated by using the equation given below:

$$C = \sum_{i,j} |i-j|^2 P(i,j) \quad \ldots\ldots\ldots\ldots (10)$$

L. Correlation
Correlation returns a measure of how correlated a pixel is to its neighbor over the whole image. The range of correlation is [-1 1]. Correlation is 1 or -1 for a perfectly positively or negatively correlated image. Correlation is NaN (Not a Number) for a constant image. The below equation is shows the calculation of Correlation.

$$Corr = \sum_{i,j} \frac{(i-\mu_i)(j-\mu_j)P(i,j)}{\sigma_i \sigma_j} \quad \ldots\ldots\ldots\ldots (11)$$

M. Homogeneity
Homogeneity returns a value that measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. The range of Homogeneity is [0 1]. Homogeneity is 1 for a diagonal GLCM. The Homogeneity is evaluated using the equation:

$$H = \sum_{i,j} \frac{P(i,j)}{1+|i-j|} \quad \ldots\ldots\ldots\ldots (12)$$

N Variance
Variance is the square root of standard deviation. The formula for finding Variance is:

$$Var = \sqrt{SD} \quad \ldots\ldots\ldots\ldots (13)$$

Where SD is the Standard Deviation**.**

Hardware and Software Requirements

Hardware Requirements
- 20 GB HDD or Onwards
- 3 GB RAM or Onwards
- P-V Processor or Onwards

Software Requirements
- Windows OS 7 or Onwards
- MATLAB 2013 or Onwards

Expected Outcomes
➢ Image pre-processing
➢ Image Segmentation
➢ Features Listing and Training
➢ Classification and Detection
➢ Disease Grading
➢ Performance Measurement

Performance Metrics

- True positive: Leaf Disease correctly identified
- False positive: Normal Leaf incorrectly identified as disease leaf
- True negative: Normal leaf correctly identified as normal
- False negative: Disease leaf incorrectly identified as normal

In general, Positive = identified and negative = rejected. Therefore:

- True positive (TP) = correctly identified
- False positive (FP) = incorrectly identified
- True negative (TN) = correctly rejected
- False negative (FN) = incorrectly rejected

Precision Rate (%) = (TP / TP+FP) * 100 …… (12)
Recall Rate (%) = (TP / TP+FN) * 100 …… (13)
Accuracy (%) = (TP+TN / TP+TN+FN+FP) * 100 …… (14)

III. CONCLUSION

Computer aided diagnosis framework using image processing methods is proposed for efficient detection and grading of leafy vegetables disease detection and analysis. The main contributions of research are discussed. The features extraction methods and features computation is presented. Crops considered for this research are different leafy vegetables. The grading of disease will be done using disease affected area measurement in %. Grading of disease will be evaluated in 1 to 4 grades based on % of disease area.

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