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Review On Plant Leaf Disease Detection System

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ABSTRACT

Agriculture is the mainstay of the Indian economy. Almost 70% people depend on it & shares major part of the GDP. Diseases in crops mostly on the leaves affects on the reduction of both quality and quantity of agricultural products. Perception of human eye is not so much stronger so as to observe minute variation in the infected part of leaf. In this paper, we are providing software solution to automatically detect and classify plant leaf diseases. In this we are using image processing techniques to classify diseases & quickly diagnosis can be carried out as per disease. This approach will enhance productivity of crops. It includes several steps viz. image acquisition, image pre-processing, segmentation, features extraction and neural network based classification.

Keywords: Image Processing, K-means Clustering, Histogram Equalization, Contour Detection And Tracing, Gray Level Co-occurrence Matrix (GLCM), K-Nearest Neighbor

1.INTRODUCTION

Agriculture has played a key role in the development of human civilization. If there is decrease in agro products, total economy will get affected. Therefore judicious management of all input resources such as soil, seed, water, fertilizers etc. is essential for sustainability. As diseases are inevitable, detecting them plays major role. One can refer incident that occurred in 2007, Georgia (USA), it is estimated that approximately 539 USD was the loss incurred due to plant diseases as well as controlling them. The naked eye observation of farmers followed by chemical test is the main way of detection and classification of agricultural plant diseases. In developing countries farming land can be much larger and farmers cannot observe each and every plant, every day. Farmers are unaware of non-native diseases. Consultation of experts for this might be time consuming & costly. Also unnecessary use of pesticides might be dangerous for natural resources such as water, soil, air, food chain etc. as well as it is expected that there need to be less contamination of food products with pesticides. There are two main characteristics of plant disease detection machine-learning methods that must be achieved, they are: speed and accuracy [1]. There is need for developing technique such as automatic plant disease detection and classification using leaf image processing techniques. This will prove useful technique for farmers and will alert them at the right time before spreading of the disease over large area. 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. Then image is segmented using the K-means clustering technique. In the second phase, unnecessary part (green area) within leaf area is removed. In third phase we calculate the texture features for the segmented infected object. Finally, in the fourth phase the extracted features are passed through a pre-trained neural network

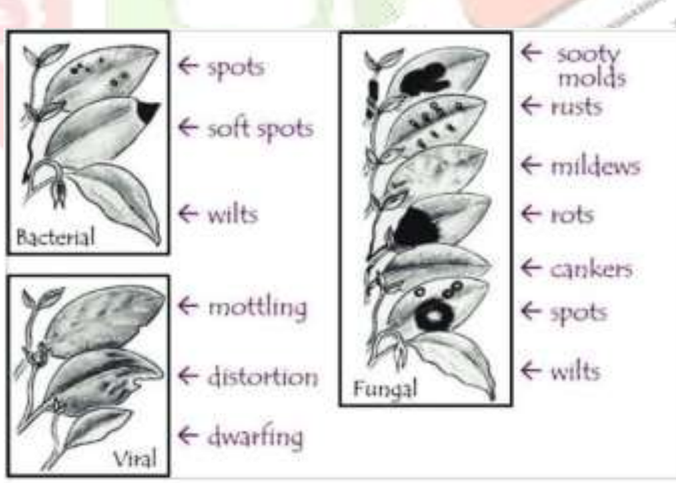

Figure . Types of Diseases

Basically crop leaf diseases are broadly classified into bacterial, viral, fungal. These are further categorized that are shown above in Figure 1. Some of them are early scorch, cottony mold, tiny whiteness, late scorch etc. Bacterial type diseases are characterized by tiny pale green spots which soon come into view as water-soaked. Among all types of diseases viral type diseases are difficult to diagnose and control once they starts spreading.

Leaves might have wrinkled, curled pattern and growth may be stunted. Fungi are identified primarily from their morphology, with emphasis placed on their reproductive structures.

2.LITERATURE REVIEW

The application of deep learning techniques in plant leaf disease detection has gained significant attention in recent years due to its potential to enhance agricultural practices. Mohanty et al. (2016) explored the use of deep learning for image-based plant disease detection, highlighting its ability to accurately identify diseases through convolutional neural networks (CNNs). Their study demonstrated that deep learning models can outperform traditional image classification techniques, providing a reliable method for early disease diagnosis, which is critical for effective crop management and protection.

Fuentes et al. (2017) conducted a comprehensive review of deep learning-based image recognition technologies for plant diseases. They emphasized the advancements in computer vision and machine learning that facilitate automated detection and classification of diseases from images. The review discusses various methodologies, including CNN architectures and data augmentation techniques, which improve the robustness and accuracy of disease detection systems. The authors also pointed out the challenges faced in implementing these technologies in real-world agricultural settings, such as the need for large, annotated datasets and the variability in disease symptoms across different plant species.

Liu et al. (2017) extended the application of deep learning to hyperspectral remote sensing image classification. Their research illustrates the effectiveness of combining hyperspectral imaging with deep convolutional networks for plant disease detection. By utilizing the spectral information inherent in hyperspectral images, their approach can differentiate between healthy and diseased plants with high accuracy. This method represents a significant advancement in precision agriculture, enabling targeted interventions based on specific disease detections.

In a different context, Mohanty et al. (2016) also investigated the relationship between crop diseases and the use of pheromones for crop protection. While this study primarily focused on biological pest control, it underscores the importance of integrated approaches that combine disease detection systems with preventive measures to enhance crop resilience.

Dawande et al. (2015) approached the problem of plant leaf disease detection using texture analysis. Their study highlights the significance of texture features in identifying diseased leaves, providing an alternative to deep learning methods. They proposed classification framework based on texture descriptors, demonstrating that traditional image processing techniques can still yield promising results in disease detection.

Ghosal et al. (2018) further contributed to the field by developing a plant leaf disease detection and classification system utilizing multi-resolution analysis and neural networks. Their research emphasizes the effectiveness of combining multiple resolution levels of images to capture various details, which enhances the classification performance. By integrating neural networks, their system can accurately identify and classify different types of leaf diseases, thus improving the overall diagnostic process.

Kalingani et al. (2020) developed a plant disease detection system using image processing techniques, including K-means clustering and feature extraction, for identifying infected leaf areas. Their method encompasses several stages: image acquisition, pre-processing, segmentation, and classification using neural networks. This approach is particularly beneficial for detecting early signs of plant disease by isolating infected regions and calculating texture and shape features, which helps farmers manage pesticide use more efficiently. This research aligns with our project goals by offering a structured image processing framework that enhances early disease diagnosis, ultimately contributing to improved crop health and yield.

Laxmaiah et al. (2023) proposed a system for detecting plant leaf diseases using image processing and neural networks. Their approach includes steps such as image acquisition, pre-processing, segmentation, feature extraction, and neural network-based classification. By using techniques like K-means clustering for segmentation and GLCM for texture analysis, the method enables accurate detection and classification of leaf diseases. This study supports our project by providing a structured framework for image-based disease identification, demonstrating the efficacy of combining traditional image processing with machine learning to improve diagnostic accuracy and reduce pesticide usage.

Overall, the literature indicates a robust trend toward employing deep learning and image processing techniques for plant leaf disease detection. The research demonstrates significant advancements in accuracy and efficiency compared to traditional methods. However, challenges remain, including the need for extensive labeled datasets and the variability of disease symptoms across different plant species. Future research should focus on addressing these challenges while exploring the integration of various technologies to develop comprehensive disease detection and management systems.

3.METHODOLOGY:

First the images of various leaves are acquired using high resolution camera so as to get the better results & efficiency. Then image processing techniques are applied to these images to extract useful features which will be required for further analysis.

The basic steps of the system are summarized as:

a) RGB image acquisition

b) Create color transformation structure & convert color values from RGB to the space specified in that structure.

c) Apply K means clustering for image segmentation

d) Masking of green pixels

e) Remove the masked cells inside the boundaries of the infected cluster.

f) Convert the infected cluster from RGB to HSI

g) SGDM matrix generation for H and S

h) Calling GLCM function to calculate the features

i) Computation of texture statistics

j) Configure neural network for recognition

Figure . Sample images from our dataset

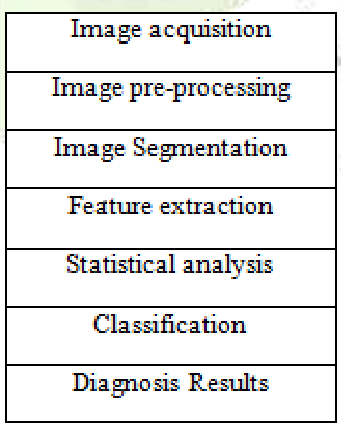

Figure . Block Diagram of proposed approach

Figure shows the basic block diagram of the proposed system. Step by step explanation of the system is as follows:

A. Image Pre-processing

Noise gets added during acquisition of leaf images. So we use different types of filtering techniques to remove noise. We create device independent color space transformation structure. Thus we 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. CIE L*a*b is a device independent color space in which a & b components carry color information .

B. Image segmentation (k-means clustering)

Image segmentation is the process used to simplify the representation of an image into something that is more meaningful and easier to analyze. K-means clustering is a partitioning method. The function 'kmeans' partitions data into k mutually exclusive clusters, and returns the index of the cluster to which it has assigned each observation. Unlike hierarchical clustering, k-means clustering operates on actual observations (rather than the larger set of dissimilarity measures), and creates a single level of clusters. The distinctions mean that k-means clustering is often more suitable than hierarchical clustering for large amounts of data. K-means treats each observation in your data as an object having a location in space. It finds a partition in which objects within each cluster

are as close to each other as possible, and as far from objects in other clusters as possible

C. Masking green pixels

In this step, we identify the mostly green colored pixels. After that, based on specified threshold value that is computed for these pixels, the mostly green pixels are masked as follows: if the green component of the pixel intensity is less than the pre computed threshold value, the red, green and blue components of the this pixel is assigned to a value of zero. This is done in sense that the green colored pixels mostly represent the healthy areas of the leaf and they do not add any valuable weight to disease identification and furthermore this significantly reduces the processing time.

D. Removing the masked cells

The pixels with zeros red, green, blue components as well as pixels on the boundaries of infected cluster are completely removed. This is helpful as it gives more accurate disease classification and significantly reduces the processing time. Infected cluster is converted from RGB to HSI color format

E. GLCM methodology

Gray level Co-occurrence matrix (GLCM) is generated for each pixel map for H & S images of infected cluster.

1. The gray comatrix function creates a gray level co- occurrence matrix by calculating how frequently a pixel with the particular intensity value i occurs in a specified spatial relationship to a pixel with the value j.
2. By default this spatial relationship is the pixel of interest and its immediate right pixel.
3. However we can specify some other spatial relationship between twos. To create multiple GLCMs, specify an array of offsets to the gray comatrix function. These offsets define pixel relationships of varying direction and distance. Directions can be horizontal, vertical, along two diagonals.
4. Calculating statistics from GLCM matrix also known as SGDM

F. Texture analysis (features computation)

1. Contrast: Returns a measure of the intensity contrast between a pixel and its neighbour over the whole image. Range = [0 (size (SGDM, 1)-1) ^2] Contrast is 0 for a constant image. C(i,j) is pixel value of location (i,j).
2. Energy= Returns the sum of squared elements in the SGDM. Range = [0 1]. Energy is 1 for a constant image.
3. Homogeneity= Returns a value that measures the closeness of the distribution of elements in the SGDM to the SGDM diagonal. Range = [0 1] Homogeneity is 1 for a diagonal SGDM.

G. Neural network based classification

The extracted features are given as inputs to pre trained neural network for automatic classification of diseases. BPNN, SVM, Radial basis functions, K- nearest neighbors are some well-known neural networks. Neural network is chosen as a classification tool due to its well-known technique as a successful classifier for many real applications. The training and validation processes are among the important steps in developing an accurate process model using NNs.

The dataset for training and validation processes consists of two parts

1. The training feature set which are used to train the NN model.
2. The testing features sets are used to verify the accuracy of the trained NN model .

Before the data can be fed to the ANN model, the proper network design must be set up, including type of the network and method of training. This was followed by the optimal parameter selection phase. However, this phase was carried out simultaneously with the network training phase, in which the network was trained using

the feed-forward back propagation network (BPNN). In the training phase, connection weights were always updated until they reached the defined iteration number or acceptable error. Hence, the capability of ANN model to respond accurately was assured using the Mean Square Error (MSE) criterion to emphasis the model validity

CONCLUSION

The study reviews and summarizes image processing techniques for several plant species that have been used for recognizing plant diseases. The major techniques used are K-means clustering, GLCM and BPNN. Some of the challenges in these techniques are optimization of the technique for a specific plant, effect of the background noise in the acquired image and automation technique for a continuous automated monitoring of plant leaf diseases under real world field conditions. The proposed approach is a valuable approach, which can significantly support an accurate detection of leaf diseases in a little computational effort. Further future work can be extended by developing better segmentation technique; selecting better feature extraction and classification algorithms and NNs in order to increase the recognition rate of final classification process. Also by computing severity and amount of disease present on the crop, only necessary and sufficient amount of pesticides can be used making agriculture production system economically efficient. So there is a scope of improvement.

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