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A method to detect diseased plant leaves using image processing in MATLAB

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ABSTRACT

In the present World scenario, agricultural farming plays a crucial role as most of people depend on it. But in the current scenario, farmers are finding it hard as the plant leaves are being affected by various diseases in the yield. Tracking plant health and finding parasites for the good crop is essential to lessen disease spread and facilitate effective management practices. In order to bring down this problem and to increase the productivity of the crop, we have put forward a technique for detecting diseased leaves rather than examining them manually. Manual monitoring of leaf disease do not give satisfactory result as naked eye observation is an old method that consumes much time for disease recognition and also needs expertise, hence it is non-effective. In view of this, we introduced a modern technique to find out diseases related to leaves. To overcome the limitations of traditional eye observations, we used a digital image processing technique for fast and accurate disease detection of plant leaves. In our proposed system there exists a software solution for the automatic detection of plant leaf diseases using MATLAB software. The proposed approaches involve image pre-processing and feature extraction. The research work carried out has the potential to be used as an effective tool for the early detection and diagnosis of plant leaf diseases, which aids farmers to take preventive measures to reduce crop loss due to diseases infecting the crop and aids in enhancing economic growth.

Keywords: *Feature Extraction, Image - Processing, Gradients of Image, Laplacian Transform, Diseased Leaf-Diagnosis.*

I. INTRODUCTION

The traditional approach for detection and recognition of plant leaf diseases is based on naked eye leaf disease detection is a major task in plant disease management, as it helps to prevent the spread of disease and protect crops from damage. Leaf diseases are a major threat to agriculture, affecting plant growth, yield, and quality. Early detection and management of these diseases are crucial for maintaining healthy crops and reducing crop losses due to plant disease. One of the primary methods for detecting leaf diseases is analyzing the leaf images by digital image processing using computer vision techniques. In recent years, computerized techniques are being preferred for the detection and diagnosis of plant diseases. Feature extraction is most significant in the process of leaf disease detection, as it involves the identification and extraction of relevant information from the image pre-processing data. This information includes color, texture, shape, and other characteristics of leaf, which can be used to distinguish healthy and unhealthy leaves.

Feature extraction is categorized into SURF and SIFT processes. SURF (Speed-ed Up Robust features) are calculated by detecting the local gradients in an image. Surf features are computed by analyzing the local gradient information in an image. This works by identifying area of interest in the image based on their salient features. Surf features finds its applications in wide range of computer vision tasks, including object recognition, image matching, 3D reconstruction, and tracking. These are mostly preferred, where there is a need to match images across different view-points or lighting conditions. Surf computes a set of image descriptors by analyzing the gradient directions and magnitudes in a local neighborhood around the point of an image.

These descriptors are computed by analyzing the gradient information in a circular region around the point, called the "Region of Interest (ROI)". The descriptor is computed by first calculating the orientation of the gradient in the region, and then computing a histogram of the gradient magnitudes in different orientations. This histogram serves as the descriptor for the interest point. Surf descriptors are invariant to scale, rotation, and illumination changes, making them robust to image transformations. This histogram serves as the descriptor for the interest point. Surf descriptors are invariant to scale, rotation, and illumination changes, making them robust to image transformations. This makes them particularly useful in applications where there is a needed to match the images across different viewpoints or lighting conditions. The speed and efficiency of Surf makes it will be suited for real time applications where speed is a critical factor.

SIFT (Scale-Invariant Feature Transform) is another computer vision process used for feature extraction, specifically for detecting and describing local features in images. The SIFT algorithm identifies and extracts distinctive features from an image that can be used fora variety of computer vision tasks such as object recognition, image matching, and image retrieval. SIFT works by detecting key points in an image that are invariant to scale, rotation, and changes in lighting conditions. These key points are then described using a set of local features such as gradient orientation histograms. The resulting feature descriptors are highly distinctive and robust to variations in the image, making them useful for matching and recognition tasks. SIFT is widely used in various applications and has been proved to perform well in most of the real-time scenarios. However, its computational complexity is a limiting factor in some cases, and these are now faster and more efficient feature extraction algorithms available. Both SIFT and SURF works for the same purpose but SURF works better compared to SIFT.

II. EXISTING METHODOLOGY

In earlier works, various algorithms are used to find out the diseases like Leaf blight, Leaf Spot, Powdery Mildew, Leaf Rust, Cancer etc., Various diseases are detected using Machine Learning and Digital Image Processing Techniques. Machine learning is a branch of Artificial Intelligence and computer science which focused on the use of data and algorithms to serve as a virtual human being, thus gradually improving it's accuracy.

Identification of different plant-Leave are considered there are: Three types of plants namely, Potato, Tomato and Bell pepper leaves are discussed by Ebrahim Hirani Atl. In particular the diseases with plants considered are early blight, mosaic virus, late blight, leaf mould, bacteria Spot, Leaf curl, Target spot, spider mite. By using Deep Learning model they performed transfer learning with both resent 34 and resent 50. New data can be added to train the model and this will not decrease the accuracy because of regularization and deeper layers of resent 50.

The plant leaf and fruit diseases namely, Black spot, Leaf Blast. It depends on K-means and Multi SVM techniques which are configured for both leaf & fruit disease detection. K-means clustering and SVM algorithm provides high accuracy and consumes very less execution time for entire processing. In the present work, different healthy and unhealthy leaf database is considered to identify the leaf diseases. Authors focused on Rice disease identification and considered the two diseases, namely Leaf Blast & Brown Spot are identified by Sandesh Raut Atl. Boundary detection & spot detection methods are used for feature extraction of the infected parts of plant's leaves. Authors introduced SOM (Self Organizing Map) neural network in zooming algorithm for classification of rice diseased images. Method of making of input vector in SOM is padding of zeros & interpolation of missing pixel values.

Santanu Phadikar Atl considered five plant diseases namely, late scorch, Cottony mould, early scorch, ashen mould and tiny whiteness from Jordan's Al-Groh area for testing. K-Means clustering method is used for segmentation of leaf images and the CCM (Colour Co-occurrence Method) method is used for infected leaf texture analysis. For classification of plant diseases, back propagation algorithm in neural network is used.

LABVIEW vision & MATLAB is used for detection of chili plant disease. Leaf inspection in early stage is possible due to combined technique of two software's. The LABVIEW is used for capturing images of leaf and MATLAB is used as image processing software Dheeb Al Bashish Atl are discussed. Edge detection, Fourier filtering, morphological operations are done with help of image pre-processing and color clustering method is used for separating chili and non-chili leaves in feature extractions. Image recognition and the classification performed here proved that chili plants are healthier.

Zulkifli Bin Husin Atl introduced a technique in which after performing image acquisition, by creating colour transformation structure, colour values are converted to space value in image pre-processing and also applied K-means method for segmentation. Unwanted region of leaf area is removed by masking of green pixels and texture features are calculated for segmented object. Additionally, all masked cells are removed. Infected clusters are converted from RGB to HSI and later SGDM matrix is generated for H & S. GLCM calculations are made for extraction of features which are then passed through the neural network for disease recognition and classifications.

Several techniques are described to detect Spot & Scorch disease in which by creating colour transformation structure, colour values are converted to space value in image pre-processing.Masked cells inside the boundaries are removed by masking of green-pixels after applying K-means method. Colour co-occurrence method extracts the features such as colour, texture & edge Prakash Atl the later stages, neural network is used for recognition and disease classification.

Smita Naikwadi Atl are described technique of Tomato leaves diseases detection and diseases are: Powdery mildew & Early blight.Image pre-processing involved various techniques such as smoothness, remove noise, image re-sizing, image isolation and background removing for image enhancement. Gabor wavelet transformation is applied in feature extraction for feature vectors also in classification. Cauchy Kernel, Laplacian Kernel and Invmult Kernel are applied in SVM for output decision & training to identify leaf diseases.

Usama Mokhta Atl introduced technique of Groundnut plant disease detection and diseases are: Late leaf spot and early leaf spot disease. In pre-processing steps RGB conversion of leaf image to HSV colour image also used co-occurrence matrices to extract colour features and statistical approach in texture feature extraction to analyse texture images. Back propagation algorithm is applied for disease recognition and classification.

Ramakrishnan.M Atl introduced technique with improved K-means method. After image acquisition, RGB image is converted to grayscale and HSV. In threshold process, histogram and multi-level threshold are obtained to isolate the required and most suited image by carrying out boundary detection to obtain required area of image. Centroid value is calculated using improved K-Means method and compare with database to obtain result.

III. PROPOSED METHODOLOGY

In the previous research works a most of the authors proposed the method of taking only a single plant leaf to identify whether the leaf is healthy or diseased, which doesn't make sense for each and every plant of different kind. Hence, in order to overcome this drawback, we have proposed a method by using SURF and SIFT features, in which image processing plays a key role. In our proposed work the method will be used to identify the diseased leaf of various plants. The method for plant leaf disease detection using image processing is carried out.In disease acknowledgment from an image, the strategic is to extract the characteristics feature of the unhealthy region. According to the disease the choices may vary. The features extracted from the image are, colour, texture etc.

Proposed Methodology for Leaf Diagnosis

In the proposed methodology we considered input as diagnosed leaf images in order to detect the diseases occurred in the yield. We are choosing different datasets (healthy&Unhealthy Leaves) in the image of various plant leaves are going to obtain a digital camera. The next stage of proposed method is to apply the image pre-processing techniques on the acquired images to extract useful features for onward analysis. Different steps are involved in the proposed approach to detect the diseases. They are given below:

Step-1: Acquisition of RGB image.
Step-2: Convert of RGB image to grey scale image.
Step-3: Extract features from the two images using SURF, SIFT.
Step-4: Compute the similarity between the two feature sets.
Step-5: Determine if the leaf is healthy or unhealthy

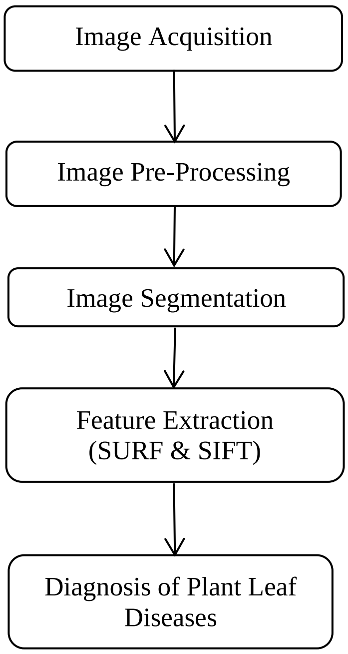


Fig.1: Basic Steps for Diseased leaf Detection

Image Acquisition

Image Acquisition is a process of capturing digital images from various sources, such as cameras, scanners and sensors. The goal of the image acquisition is to convert the physical image into the digital format so that they can be processed. There are several factors to consider when acquiring images, including resolution, colour depth, and file format. Resolution refers to the number of pixels in an image, and higher resolutions generally result in more detailed images. Colour depth refers to the number of bits used to represent each colour, and higher colour depths allow for more accurate colour representation.

The file format chosen for image acquisition depends on the intended use of the image. Common file formats for digital images include JPEG, PNG, and TIFF, each with their own advantages and disadvantages. Image acquisition can be performed manually by an operator, or it can be automated using computer software. In either case, the goal is to obtain high-quality digital images that accurately represent the original physical.

Image Pre-Processing

Image pre-processing is a technique used to prepare digital images for analysis or further processing. The goal of image pre-processing is to enhance the quality of an image, remove noise and extract relevant information from the image.Image pre-processing techniques can be divided into several categories, including:

Image filtering: This involves applying mathematical operations to an image to remove noise or enhance specific features. Common types of filters include Gaussian blur, median filter, and edge detection filters.
Image enhancement: This involves adjusting the brightness, contrast, or color balance of an image to improve its visual appearance or highlight certain features.
Image normalization: This involves scaling the pixel values of an image to a specific range or standardizing the image's brightness and contrast.
Image segmentation: This involves dividing an image into smaller, meaningful regions based on their visual properties. This is often used to identify objects or boundaries within an image.
Image registration: This involves aligning multiple images to a common reference frame, which can be useful for tracking changes over time or creating composite images.
Image pre-processing is an important step in many image analysis tasks, such as object detection, recognition, and tracking. By improving the quality and extracting relevant information from an image, pre-processing can make subsequent image analysis tasks more accurate and efficient.

Image Segmentation

Image segmentation is the process of dividing an image into multiple regions or segments, each representing a different object or part of the image. The goal of image segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyse. Image segmentation can be performed using a variety of techniques, including:

Thresholding: This involves selecting a threshold value and assigning pixels in the image as foreground or background based on whether their intensity values are above or below the threshold.
Region-based segmentation: This involves dividing an image into regions based on similar properties, such as colour or texture.
Edge detection: This involves identifying the boundaries between objects in an image by detecting edges or gradients in intensity
Clustering: This involves grouping similar pixels together based on their features, such as colour or texture.
Watershed segmentation: This involves treating an image as a topographic map and dividing it into regions based on the contour lines of the map.
Image segmentation is an important technique in many image processing and computer vision applications, such as object recognition, tracking, and image compression. It can be used to extract specific features or objects from an image, or to partition an image into regions for further analysis. The choice of segmentation technique depends on the properties of the image and the desired output of the segmentation process.

Feature Extraction

Feature extraction is the process of selecting and representing relevant information, or features, from raw data. In the context of image processing and computer vision, feature extraction involves identifying distinctive patterns, shapes, colors, or textures that can be used to describe and differentiate objects in an image.The goal of feature extraction is to transform high-dimensional and often noisy data into a lower-dimensional and more meaningful representation, which can be used for further analysis, classification, or recognition. The features should be robust, discriminative, and informative, meaning that they should capture the essential characteristics of the objects in the image and be invariant to changes in lighting, scale, rotation, and other variations.Feature extraction can be performed using various techniques, ranging from handcrafted feature descriptors to deep learning-based feature extraction networks. Some popular feature extraction techniques are:

Scale-invariant feature transform (SIFT): SIFT is a feature extraction algorithm that detects distinctive key points in an image and extracts their local features, such as gradient orientation and magnitude. SIFT features are invariant to scale, rotation, and translation and can capture the geometric and texture information of objects.

SURF is an extension of SIFT (Scale-Invariant Feature Transform) and is designed to be more efficient and robust to noise and distortion.The main idea behind SURF is to use a fast approximation of the Laplacian of Gaussian (LoG) filter to detect key points in an image, and then to describe the local neighbourhood of each key point using a set of orientation sensitive Haar wavelet responses. The Haar wavelets are applied to a set of overlapping sub-regions around each key point, and the resulting responses are combined into a compact feature vector.

The advantages of SURF over SIFT are its speed and robustness. SURF uses an approximation of the LoG filter that can be computed using box filters, which are much faster to compute than Gaussian filters. SURF also uses a faster algorithm to detect key points and a more robust descriptor that is less sensitive to changes in illumination and viewpoint. SURF has been used in many computer vision applications, such as object recognition, tracking, and image registration. It has also been applied in robotics and autonomous systems, such as UAVs and self-driving cars, for tasks such as obstacle avoidance and localization.

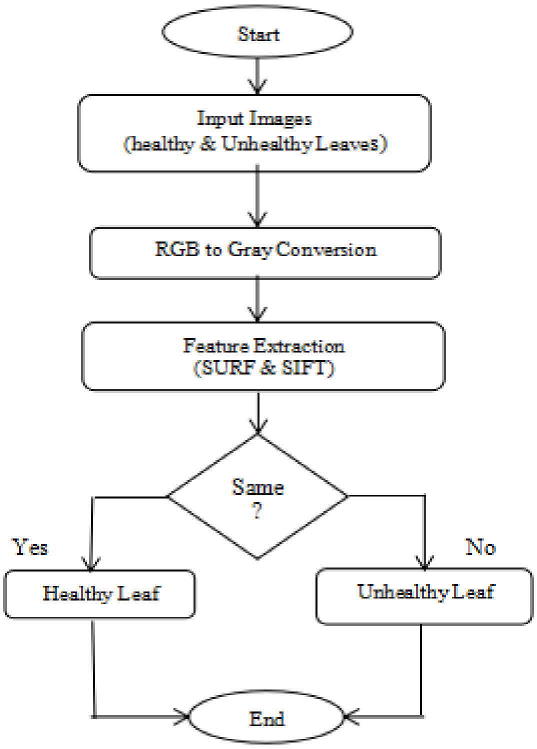


Fig.2: Flow chart for Proposed Methodology

IV. DIAGNOSIS OF PLANT-LEAF DISEASES

After processing the above steps and completing the execution of the raw images, if the leaf is healthy, it will pop-up a message showing that "it is a healthy leaf" and if the leaf is unhealthy it will show "it is an unhealthy leaf". By using this process, we can easily detect the detect the diseases occurring in the yields it will very helpful to increase the product the growth.

Leaves considered for Diagnosis of diseased leave

Here we have considered different datasets of leaves as input for diagnosis to detect the diseases occurring in the crops. Those are shown in below:

(a) Healthy leaf (b) Unhealthy Leaf

Fig.3 : Maple Leaves

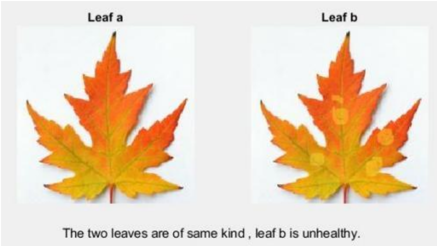
(a) Healthy Leaf (b) Unhealthy Leaf

Fig.4: Grapes Leaves

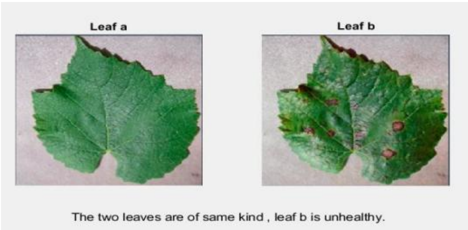
After considering input from the leaf diagnosis we are convert the RGB image into the Gray scale image Then extract the features of leaf like texture, shape, colour etc., by using feature extraction techniques those are SURF (Speeded-up Robust Features) and SIFT (Scale Invariant Feature Transform) and it will check the similarity of the image if the two leaves are same kind of leaves are not and it display as output result.

V. RESULTS &DISCUSSIONS

We are taking these diagnosed leaves as the input and these leaves are in RBG form. The images in RGB form are converted into Gray scale images. After that the leaf features like texture, shape, color…etc., are extracted by using the feature extraction techniques they are SURF (speed up robust features) and SIFT (scale invariant feature transform). Those characteristics are stored in the point1 and point2. Then it will check the similarities between two leaves. It will check the no of rows in the similarity matrix to determine if there are enough matches between the two leaves to classify them as same kind and healthy. Based on the threshold of at least 15 matches between the two leaves. If there are at least 10 matches the code prints healthy. If there are less than 15 matches the code prints unhealthy In results it will check the similarities of the images from figure 3 &4 and obtain the result as output.



(a)



(b)

Fig.5: Resultant Output

VI. CONCLUSION

The accuracy of the classifier can be further improved by optimizing the feature extraction and classification algorithms. The development of such models can contribute to the early detection and prevention of plant diseases, which is essential for maintaining healthy crops and improving agricultural productivity.

As a future work, extensive database of leaves collection can be utilized and the analysis can be carried out at a time by using advanced technology such as drone to perform the function for huge number of leaves/plants crop at a time and hence reducing the execution time for efficient result as well.

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