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Diseased Plant Leaf Prediction using Image Processing and Multi-SVM

[1]Halaswamy B M

[1]Senior Scale Lecturer
[1]Electronics and Communication Engineering,
[1]Government Polytechnic, Hiriyur, India

Abstract: Agriculture plays a pivotal role in determining a nation's prosperity, particularly in a country like India where over 68% of the population relies on it for their livelihoods. Crop infections pose a significant threat, not only to the livelihoods of farmers but also to the overall economic stability of the nation. Effective measures must be taken to diagnose and treat plant diseases promptly in order to mitigate substantial losses and safeguard crop yields. In this study, we propose a novel approach combining image processing and machine learning techniques to identify and classify plant leaf diseases. Our method utilizes a multi-class Support Vector Machine (SVM) classifier, incorporating texture analysis using Gray-Level Co-occurrence Matrix (GLCM) features. The results of our predictive model exhibit promising outcomes, achieving an impressive accuracy rate exceeding 90% during the simulation phase, which holds great potential for practical implementation in the agricultural sector.

Keywords: Disease, Plant Leaf, SVM Classifier, image processing, machine Learning.

I. INTRODUCTION

The agriculture sector's annual crop production rate plays a crucial role in determining a country's economic growth. Agriculture contributes over 18% to the country's total GDP, and the quantity and quality of crop production are influenced by various weather conditions and diseases that affect plants and crops. [1]. Failure to promptly identify and address these diseases can result in significant crop damage and financial losses for farmers. In our subcontinent, more than 35% of crop losses are attributed to many factors such as diseases, pests, and weeds. This issue becomes even more critical in countries with extensive cultivation fields, where losses can escalate.

The rapid spread of diseases among plants is a pressing concern, as even a single-infected plant can quickly contaminate others. Thus, early disease detection is of paramount importance to mitigate substantial losses and damage. Unfortunately, many farmers lack the necessary literacy and expertise to identify these diseases and apply the appropriate pesticides promptly. Consequently, they often seek the assistance of agricultural experts, which can be a costly endeavor, and the accuracy of such predictions by experts may not always be foolproof. [2]. To address this issue, we present a solution leveraging artificial intelligence to assist farmers in disease detection, offering accurate results at a lower cost. In this we employ auto-mated plant leaf disease-detection and classi-fication through image pre-processing and a multi_svm classifier, which has demonstrated its effectiveness in delivering precise outcomes within a shorter timeframe. This innovative model empowers farmers with a reliable disease detection tool, achieved by scanning plant leaves using advanced image-processing techniques and a streamlined machine-learning process. The model's workflow can be summarized as follows: firstly, the collection of leaf datasets to train the machine learning algorithm, followed by image processing, culminating in the classification of diseases with high accuracy, thanks to the multi_svm classifier.

II. LITERATURE REVIEW

In the study conducted various researchers focused on detecting plant leaf infections through image processing techniques. Their research involved the collection of approximately 75 images of diseased leaves, which were classified into five categories: four representing various diseases and one representing healthy leaves. They implemented a preprocessing step to eliminate common artifacts and backgrounds from the images. Subsequently, they applied the Otsu segmentation algorithm to segment the images and extracted relevant features for disease classification using a specialized classifier. However, it's important to note that their study did not specify the exact level of accuracy achieved with their proposed method, possibly due to the use of a relatively small dataset for experimentation.

Another scholar presented a paper that explores the application of a Convolutional Neural Network (CNN) model for predicting leaf diseases. In the dataset, curated approximately 500+ images, with 400 designated for tra-ining purposes, and the remaining 100 for testing. The classification task involved five distinct classes. The image size was standardized to 512x512 pixels. They employed three separate frameworks for the Red-Green-Blue (R, G, B) colour-channels to contribute to the CNN model. The results obtained from this CNN model were then fed into a neural-network known as L.V.Q (Learning-Vector-Quantization). Remarkably, their proposed model achieved an impressive accuracy rate of approximately 88%. It's important to note that their research was specifically tailored for addressing tomato-related diseases.

K. Elangovan and S. Nalini's paper employs Support Vector Machines (SVM) for a specific purpose. Their approach involves a multi-step process, where the image is initially transformed into a different color space. Subsequently, the image is cropped, followed by a series of image preprocessing steps to remove noise and apply smoothing, ultimately converting the image into grayscale. Further processing involves segmentation, and from there, relevant features are extracted. Notably, these features encompass color, morphology, and texture, which are utilized for classification purposes. However, it's important to mention that the paper does not provide details regarding the accuracy achieved by their proposed model. In this focus is on employing the K-means clustering algorithm to segment images, effectively dividing them into k clusters. This segmentation technique helps isolate the image region containing the most undesirable elements, such as diseases. In their approach, they identify infections by utilizing the Random Forest Classifier. However, it's worth noting that this classification method is both time-consuming and intricate in its implementation[3].

Suja Radha [4] presented an approach aimed at identifying the affected regions on leaves. To achieve this, the segmentation technique employed was K-means clustering. In the classification step, Support Vector Machine (SVM) was utilized, a choice justified by its ability to handle high-dimensional data spaces more effectively compared to other classifiers. Another innovative techniques for disease detection. They discussed the utilization of the Otsu Threshold algorithm and the K-means algorithm for image segmentation. Additionally, their approach involved the Color Co-occurrence method, as well as leaf color extraction using H and B components, for feature extraction. Furthermore, they conducted a comparative analysis of ArtificialNeuralNetworks (ANN) and Backpropagation Neural Networks (BPNN) classifiers for disease classification.

In their research, P. Kaur et al. [5] explored a method for detecting diseases in cucumber plant leaves. They employed a pattern recognition approach to segment healthy and infected areas within the leaves. Subsequently, they extracted features related to color, shape, and texture from these segments. These features were then fed into a Support Vector Machine (SVM) for classification, which yielded highly satisfactory results. Notably, the study found that the performance of SVM surpassed that of neural networks in disease detection.

III. METHODS AND MATERIALS

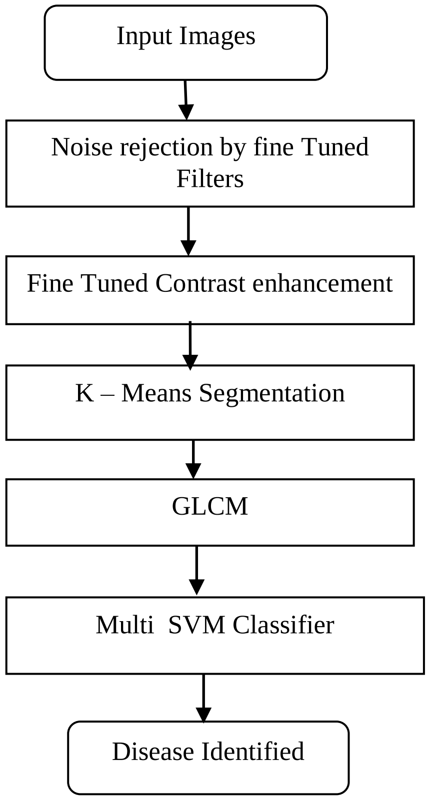

Figure 1: Flow diagram for Proposed Method

FOLLOWING IS THE DETECTION PROCESS

IMAGE ACQUISITION:

In this process, we commence by importing a digital color image, acquired through a digital Imager, which serves as the initial input for the subsequent stage within this process, as illustrated in Figure 1.

Image Pre-processing:

To improve image quality and eliminate undesirable artifacts, we employ a finely-tuned noise removal mean filter. This filter effectively eliminates noise, resulting in cleaner images. Furthermore, we enhance the image's contrast to accentuate dark regions, thereby facilitating greater clarity for subsequent stages in the segment-ation and feature extraction process.

IMAGE SEGMENTATION:

This process uses k-means segment-ation algorithm for separating the regions of affected and nonaffected areas from the leafimage.

FEATURE EXTRACTION:

Utilizing the GrayLevel Cooccurrence Matrix (GLCM), we capture the spatial relationships between pixels, allowing us to extract a comprehensive set of 13 statistical features. These features are subsequently subjected to training and testing within the classifier."
Multiclass SVM

"We harness the power of classifiers to both train and assess our datasets, with a specific focus on employing the multisvm classifier. Our aim is to distinguish between healthy-unhealthy plant leaves and analyze the resulting outcomes. The multisvm classifier, a form of multi-class support vector machine, is adept at addressing multi-class classification challenges.
This classifier excels in high-dimensional spaces, outperforming alternative classification techniques in terms of classification accuracy. Despite some distortion in the training data, SVM proves highly reliable. It's worth noting that training time may be substantial when working with extensive datasets, particularly when transforming raw data into a higher-dimensional representation."

IV. SIMULATION RESULTS

The simulation results is as follows.

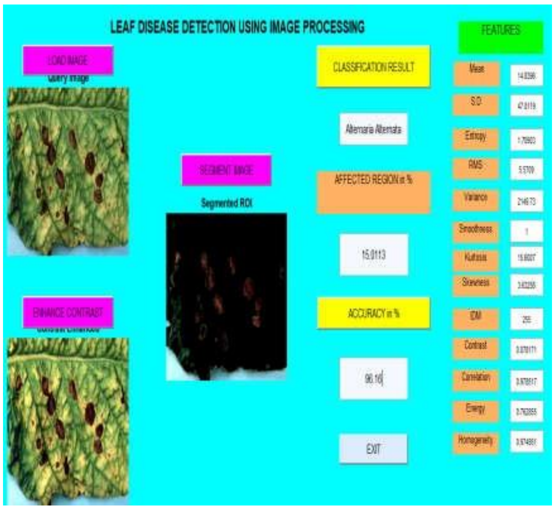

Figure- 2. Overview

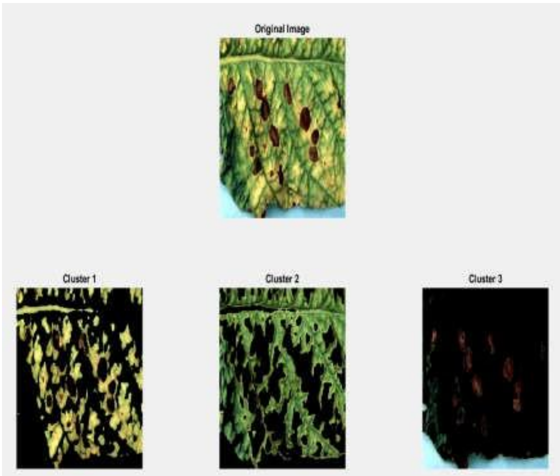

Figure 3. Image segmentation

Table1: Accuracy Table

Sl. No.	Disease	Diseased Region (%)	Accuracy when no fine tune (%)	Accuracy when fine tune (%)
1	Alternaria Alternata	16.21	87.2	95.1
2	Bacterial Blight	14.34	87.45	93.23
3	Anthracnose	15.2	84.250	94.22
4	Cercospora Leaf Spot	16.21	86.1	95.2
5	Healthy leaf	None	91.23	97.8

V.CONCLUSION

"This study explores the detection of leaf diseases through an extensive dataset of diverse images, utilizing a combination of innovative techniques. We employ a carefully tuned image pre-processing step to enhance image quality, eliminating undesirable noise and optimizing contrast. Subsequently, a K-means segmentation approach is applied to facilitate feature extraction, with a specific focus on texture features.

A key aspect of our investigation involves comparing the performance of multiSVM classification with and without the finetuned image preprocessing step. Our findings demonstrate a tangible improvement when employing this pre-processing approach. In conclusion, our methodology not only enhances disease detection accuracy but also enables the precise identification of various types of plant leaf diseases, further enhancing the potential for early diagnosis and intervention."

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