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A Survey on Plant disease detection using image processing and deep learning

Aarti Pimpalkar[1] , Chaitali Ranaware[2] , Ramsha Shaikh[3] , Madhura Throat[4]

Assistant Professor,Department of computer Engineering, Sinhgad Academy of Engineering, Pune, India [1]
Student, Department of Computer Engineering, Sinhgad Academy of Engineering, Pune, India [2,3,4]

SITE'S SINHGAD ACADEMY OF ENGINEERING KONDHWA BK

***Abstract*—Agriculture is a significant sector in India with over 70% of the population depending on it for their livelihood. Crop diseases can lead to substantial losses for farmers, especially when the cultivated area is vast. Monitoring crops regularly becomes a tedious task for cultivators, and timely and accurate detection of plant diseases is crucial for maintaining crop quality and yield. Early diagnosis and intervention can help reduce the loss of plant disease and minimize the unnecessary use of drugs. Therefore, plant disease detection plays a crucial role in agriculture, and developing efficient detection methods is essential for the growth and success of the agricultural sector.**

Keywords- Image Processing, Machine Learning, Feature Extraction, Image Global Features, Classification.

I. Introduction

The economic prosperity of farmers is closely tied to the quality of the crops they cultivate, which in turn depends on the health and productivity of the plants. Unfortunately, plants are vulnerable to various diseases that can affect different parts of their anatomy, such as leaves, stems, seeds, and fruits. In recent years, machine learning techniques have emerged as a promising solution for identifying and classifying plant diseases from images of plants. This is especially important for crops that are vital for the economy of countries like India, where agriculture plays a dominant role and provides livelihoods for millions of people. For instance, in India, cash crops are of paramount importance and provide direct employment to around 6 million farmers and indirectly to about 40-50 million people.

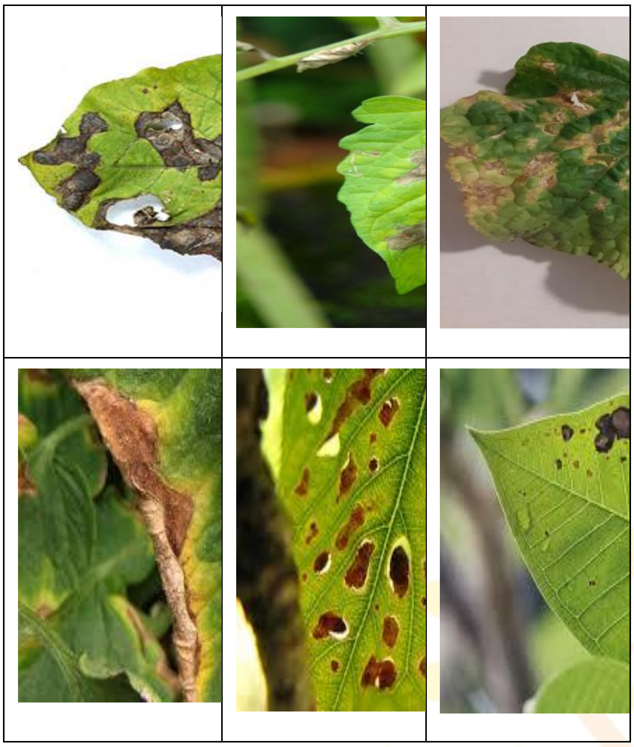
II. LITURATURE SURVEY

1. Prasanna Mohanty et al. presented a technique for identifying plant diseases through an Image-Based Plant detection using a Convolutional Neural Network (CNN) in their paper. The CNN model was trained to distinguish between healthy and diseased plants of 14 species, achieving a remarkable accuracy of 99.35% on test set data. However, when tested on images obtained from trustworthy online sources, the model's accuracy dropped to 31.4%. [1]While this result outperforms a simple random selection model, augmenting the training data with a wider range of samples can improve the accuracy.

2. Malvika Ranjan et al. proposed a method for detecting plant diseases by capturing images of diseased leaves and using an Artificial Neural Network (ANN) trained on selected feature values to distinguish healthy and diseased plants. The ANN model achieved an accuracy of 80%. In a separate study by S. Arivazhagan, the disease identification process was divided into four steps: first, the input RGB image was transformed into a color structure, then a specific threshold value was used to detect and exclude green pixels[3], followed by a segmentation process and computation of texture statistics to obtain useful segments. Finally, a classifier was used to classify the disease based on the extracted features

3. Emaneul Cortes proposed an approach to detect plant disease using Generative Adversarial networks in the paper "Plant disease detection using CNN and GAN" [5]. The approach involves using background segmentation to ensure proper feature extraction and output mapping. While the use of GANs showed potential for accurately

classifying plant diseases, the technique of segmenting based on background did not lead to a significant improvement in accuracy.



III.METHODOLOGY

The process of detecting whether a leaf is diseased or healthy involves several steps, including pre-processing, feature extraction, training of the classifier, and classification. Pre-processing involves re-sizing all the images to a uniform size. Feature extraction is performed using the HOG [6]feature descriptor, which describes the appearance of the object and the image outline using intensity gradients. Three feature descriptors are used in this system.

The first step is to convert the RGB image to grayscale and calculate the Hu moments, which provide shape descriptors. Haralick texture is used to distinguish between the textures of healthy and diseased leaves, as they usually have different textures. This feature is based on the adjacency matrix, which stores the position of pixels. To calculate Haralick texture, the image must first be converted to grayscale.

The proposed system uses grayscale images of size 28x28 as input, and the first layer of the CNN applies 32 filters to the input images, producing 32 feature maps of size 26x26. The second layer applies 64 filters of size 3x3, producing 64 feature maps of size 24x24.[7] The third layer is a max-pooling layer that down samples the images to 12x12 using a sub-sampling window of size 2x2.
One advantage of CNN's is that they have a distinct architecture compared to regular neural networks, which allows them to take input images of different sizes. This makes them well-suited for image classification tasks such as plant disease detection.

IV.System Architecture

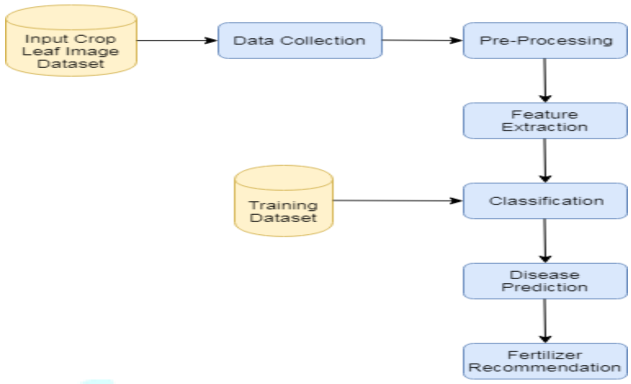


Figure 1.Shows the overall system architecture.The user will upload the image of the leaf that will be scanned by the model

V. IMPLEMENTATION

Figure 2. shows the data set containing the healthy and unhealthy leaves

A. Data-set:
The dateset used for training the model comprises of 54303 leaf images exhibiting both healthy and unhealthy conditions, which have been classified into 38 categories based on the species and type of disease present.

B. Training:
The process of diagnosing leaf diseases is a multifaceted approach that involves various tasks, including image acquisition, pre-processing, feature extraction, and classification. The initial step is the image acquisition phase, where leaf images are sourced from various data sets. The second phase involves image pre-processing, where techniques are applied to enhance the quality of the image. The next step is feature extraction, where specific properties of pixels in the infected part of the leaf, such as color and texture, are analyzed to extract the necessary features. Finally, statistical analysis is conducted to classify the image features, and machine learning algorithms are utilized to compare these features and diagnose the type of disease present.

C. Testing:
The evaluation of the model is conducted on a set of new, previously unseen images that are distinct from the ones used for training. The performance of the model is assessed under various levels of difficulty, ranging from easy to medium and hard cases. Based on the evaluation results, an estimation of the model's performance can be made.

VI.RESULT

The data set is split into 70% for training and 30% for testing, and texture and color features are extracted and selected to obtain the best feature subset for input into classification algorithms. K-means is used as a classifier, which yields an 85.3% accuracy. SVM is also employed without feature selection and with k-means segmentation, resulting in a 90% and 89% accuracy, respectively, when using a linear kernel. RBF and polynomial kernels achieved 88.8% and 90.2% accuracy, respectively. The proposed segmentation process is applied to obtain the best feature subset, and SVM classification accuracy improves to 95.63%, 94.23%, and 95.78%. Other algorithms such as C4.5 and Naive Bayes yield accuracies of 89% and 86%, respectively, while MLP with Back-propagation results in an 88.59% accuracy. The optimized MLP obtains an accuracy of 91.45%. Additionally, CNN is used for both training and testing purposes to identify diseased leaves based on their features, yielding a high accuracy rate of 98%

VII.Conclusion

The developed system aims to benefit the agricultural sector and farmers by detecting plant diseases and suggesting appropriate remedies to improve plant health. This system, built using Python, achieves an impressive accuracy rate of approximately 95%. With early detection of leaf diseases, farmers can take preventive measures to protect the plant from further damage. The use of classification and feature extraction techniques has improved the performance of the system, resulting in better results.

However, the computational time required to process these images is relatively high compared to normal JPEG images. To enhance the system's accuracy, it is recommended to stack the model with more layers and train the network using more image data, utilizing clusters of GPUs. Future enhancements will focus on the segmentation of larger, colored images, which will be highly useful in the image segmentation process.

VIII. FUTURE SCOPE

1. Mobile Application Integration: In the future, plant disease detection applications that use CNN can be integrated into mobile devices to enable farmers to identify plant diseases in real-time.

2. Expansion of the Data-set: Increasing the size and diversity of the data-set used for training the CNN model will result in a more accurate and comprehensive disease identification system.

3. Multi-Class Detection: Currently, most plant disease detection applications that use CNN can only detect a limited number of diseases. Future applications can be developed to detect multiple diseases and classify them according to their severity.

4. Real-Time Detection: As technology advances, plant disease detection applications can be developed to provide real-time detection of plant diseases using live video feed.

5. Automated Treatment Recommendation: Future plant disease detection applications can be developed to recommend automated treatment based on the identified disease. This can help reduce the time and resources required for manual diagnosis and treatment of plant diseases.

6. Collaboration with Agricultural Experts: Collaboration with agricultural experts can help develop more accurate and comprehensive disease identification systems. By integrating expert knowledge with machine learning algorithms, plant disease detection applications can become more reliable and effective in identifying and treating plant diseases.

IX.ACKNOWLEDGMENT

The aim of this paper is to propose a technique for accurately detecting various diseases on plant leaves at an early stage, thus preventing damage to the entire plant and achieving good productivity. The proposed technique combines weather data-set and image processing to analyze the diseases, and can effectively detect the presence of diseases. The results demonstrate the potential of this approach for improving plant health and productivity through disease prevention..

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