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Plant Disease Detection Using Deep Learning

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Abstract: ***The system today operates using images, with its pre-processing that makes use of models like Inception-V3 CNN; such models are computational resource- demanding, requiring humongous sizes, and enormous data storage capacity. It is hence both time and cost-expensive. The proposed system uses the AlexNet CNN model in MATLAB R2021A with an accuracy of almost 99.6% to classify plant diseases, thus making it efficient, cost- effective, and faster due to the modules used such as acquisition of images, preprocessing, disease classification, and performance evaluation in the identification of ten diseases, which include Apple Black Rot and Grape Black Rot.***
Keywords: CNNs, GLCM, RBF kernel, SVM, VGG-16.

I. INTRODUCTION

This project helps farmers identify plant diseases by analyzing leaf images using deep learning, particularly convolutionalneural networks (CNNs). Catching diseases early is key, as they can spread quickly and damage crops.

By studying plant traits, farmers can spot problems early and take action to protect their crops. When combined with the agricultural Internet of Things (IoT), CNNs allow for real-time disease detection and severity assessment, saving farmers time and money. Techniques like PiTLiD, which uses transfer learning with a pretrained InceptionV3 model, work even with limited data, helping farmers manage crop health more effectively.

II. LITREATURE SURVEY

A. Plant Disease Detection Using Machine Learning

Shima Ramesh, Niveditha M, Pooja R, Prasad Bhat N, Shashank N department of electronics and communication, MVJ college of Engineering. Bangalore,

India agriculturists in the provincial regions are not able to diagnose possible diseases affecting the crops. Such methodologies cannot be expected to visit even the agricultural office to diagnose the kind of illness or disease. We primarily focus on finding plant diseases with the help of morphological analysis using machine learning and image processing techniques.

Pests and diseases can damage crops, resulting at times in low food output and food poverty. In less developed countries, little is known about pest management, disease control, and prevention. The major reasons resulting in low food supply are toxic infections, poor disease control, and climatic change.

Recently, modern technologies have developed that minimize the postharvest processing along with maximizing agricultural sustainability to output. The hyperspectral methods along with gas chromatography and polymerase chain reaction are cheaper and less time consuming. Techniques along with powerful web or mobile server processing along with the help of high-resolution cameras, became time-efficient. Even the technique of machine learning and deep learning has employed for recognizing efficiency and accurate identification rates. Some of the traditional machine learning approaches include random forest, artificial neural networks, support vector machines, fuzzy logic, the K-means method, and convolutional neural networks. HOG is utilized for object detection in computer vision and image processing. Three component descriptors are used, hu Moments, haralick texture, color histogram. Hu moments are used to identify the shape of leaves. Haralick texture is used to attain leaf texture and color. A histogram represents the colors of an image that distribute its histogram range.

B. Automatic Prediction and Classification of Diseases in Melons using Stacked RNN based Deep Learning Model

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Agriculture is vital for the development of our nation's economy. Whenever crops are sown in the fields of farmers, profit is at its maximum. Thus, it should be tracked by identifying the disease in the plant well before harvest time. We are employing the use of automatic detection of plant disease and classification for this task, which is a very critical area of study because it might throw open the benefits of scanning an enormous field region of plants.

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Thus, it is very much important to identify and diagnose diseases in agricultural plants within the agricultural sector. In controlling the disease early on, farmers face a number of problems. To combat this, we are anticipating and classifying diseases, which is a very important task in agriculture. This also involves diagnosing the diseases and taking the necessary steps in controlling the significant losses that they produce. The melon plant disease seems to appear hard to diagnose when the other plant diseases are placed side by side. Because of this, taking the fast, simple, and cheap method to predict as well as categorize over a wide area of the agricultural area melons' plant diseases into consideration.

Farmers can make use of image processing in detecting these diseases and stopping them before they affect the crop's output. To differentiate between these areas of illness, we use a deep learning model known as Stacked RNN (Recurrent Neural Network). For this purpose, we have designed a deep learning model, Stacked RNN (Recurrent Neural Network), that will help recover from diseases in infected areas as early as possible. For this system, based on a large farm, early identification and classification of melon plant illness is required; we use four key strategies: pre-processing, feature extraction, segmentation, and classification. The application in this research will target the Stacked RNN technique for image detection and segmentation that result from preprocessed images.

C. Identification of Plant Diseases Using Image Processing and Image Recognition

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In the view of plant diseases threatening agricultural productivity, timely detection in order to control losses in crops is very important. In traditional methods for the detection of plant diseases, visual inspection is used, which is time- consuming and of expert knowledge in most cases. The newly developed efficient alternative is the use of image processing techniques to automate disease detection with much better accuracy and lesser cost.

This study puts forward a proposal of the identification of a plant disease based on images processed using algorithms of machine learning. The whole process starts from image acquisition, where pictures of the leaves of plants are captured and converted to RGB. Before pre-processing, techniques like smoothing filters and contrast adjustment reduce the noise and enhance the features of the image. Later on, image segmentation is used, usually based on the K-means clustering technique as well as edge detection to capture the infected areas on the leaf.

Feature extraction plays an important role in providing data points for defining characteristics of the disease. The paper utilizes color histograms, texture analysis, and shape features, which are further processed to differentiate between healthy and diseased leaves. Further experiments were done with CNN and SVM as classifiers for the categorization of images based on extracted features. Multiple experiments showed the proposed model to have accuracy on various plant diseases.

This approach has a very significant advantage of adapting well to real-world conditions. While controlled lab environments give results that are exact, field testing supplies useful insight about the robustness of the model under changing conditions. With the incorporation of various images while training, the model increases performance with real-life datasets in helping farmers detect diseases early, which could bring up yields and economic outputs.

D. A Machine Learning Technique for Identification of Plant Diseases in Leaves

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The traditional methodologies to detect plant diseases include visual detection, which is expensive and time consuming. Machine learning promises to detect plant diseases non-invasively with the highest accuracy from images of leaves.

The article introduces a machine learning- based plant disease-identification model. It focuses on the extraction of features and classification from leaf images. It begins with the RGB image capture of plant leaves, preprocessed to obtain better quality. Feature extraction, with techniques such as the Gray Level Co-occurrence Matrix (GLCM), captures the essential textural characteristics, such as contrast, correlation, and energy. This step is how the model differentiates between a healthy and diseased leaf based on unique leaf texture patterns.

The training dataset consists of images of various plant diseases. Thus, the model can learn the classification boundaries very effectively. K-means clustering is used to divide the regions of interest within the images, and Support Vector Machine classifiers are used for the final classification into predefined classes, such as healthy, Alternaria Alternata, Anthracnose, Bacterial Blight. Experimental results are highly accurate in disease-type identification, promising timely, automated disease detection. An ML-based approach can therefore aid farmers with early intervention to reduce losses and produce healthier crops.

E. PiTLiD: Identification of Plant Disease From Leaf Images Based on Convolutional Neural Network
Kangchen Liu and Xiujun Zhang

In plant disease, especially on important crops economically, potential yield loss has created this problem. Traditional detection methods for disease, that are time- consuming, require a lot of the practitioner's expertise, interest is developing in automated techniques. Convolutional Neural Networks (CNN) promises as a non- invasive machine learning solution for the identification of plant diseases from leaf images.

PiTLiD is a CNN-based approach that uses the pre-trained Inception-V3 model with transfer learning on leaf images to classify plant diseases. The main processes it uses are image preprocessing and data augmentation, followed by classification on leaf images using the model. Features may include color patterns, textures, and shapes that define the difference between healthy leaves and diseased ones.

The developed algorithm is then tested with a dataset of apple leaf images and enhances the mini-batch size to achieve a result of 99.45% accuracy by undergoing multiple data augmentation techniques. The first stage involved the pre-processing stage where it enhanced its performance by making the model apply scaling, horizontal flipping, and rotation of images. This dataset has been drawn from the database named as PlantVillage database, further divided into an apple leaf disease dataset in which a pre-trained algorithm was imported from the ImageNet model. Although the accuracy of the system is extremely high, it depends upon the quality of data as well as computational demand to conduct real-time analyses. Yet, PiTLiD is an exciting advancement towards automated plant disease detection, with the potential to help improve yield predictions and cut crop loss.

III. RESULT

The model was built using a pre-trained Inception-V3 architecture, initially trained on ImageNet. It was adapted for apple disease classification by modifying the output layer to classify four categories: black rot, cedar apple rust, healthy, and apple scab. The network's fully connected layers were removed, and the feature extraction part was restructured into three blocks. Hyperparameters, including optimizer (RMSprop), batch size, learning rate, and epochs, were fine-tuned using a cyclical learning rate strategy. Transfer learning was applied, where the feature extraction layers were kept from the ImageNet model, and the classification module was initialized randomly to focus on apple disease features.

The model was evaluated using the Plant Village dataset, with 3,171 images split across training, validation, and test sets. The best-performing model used RMSprop, batch sizes of 32 (training) and 16 (validation), 50 epochs, and early stopping with L2 regularization, achieving high accuracy in classifying apple diseases.



Fig: The output of the training algorithm Inception V3 , Disease detected as Tomato early blight

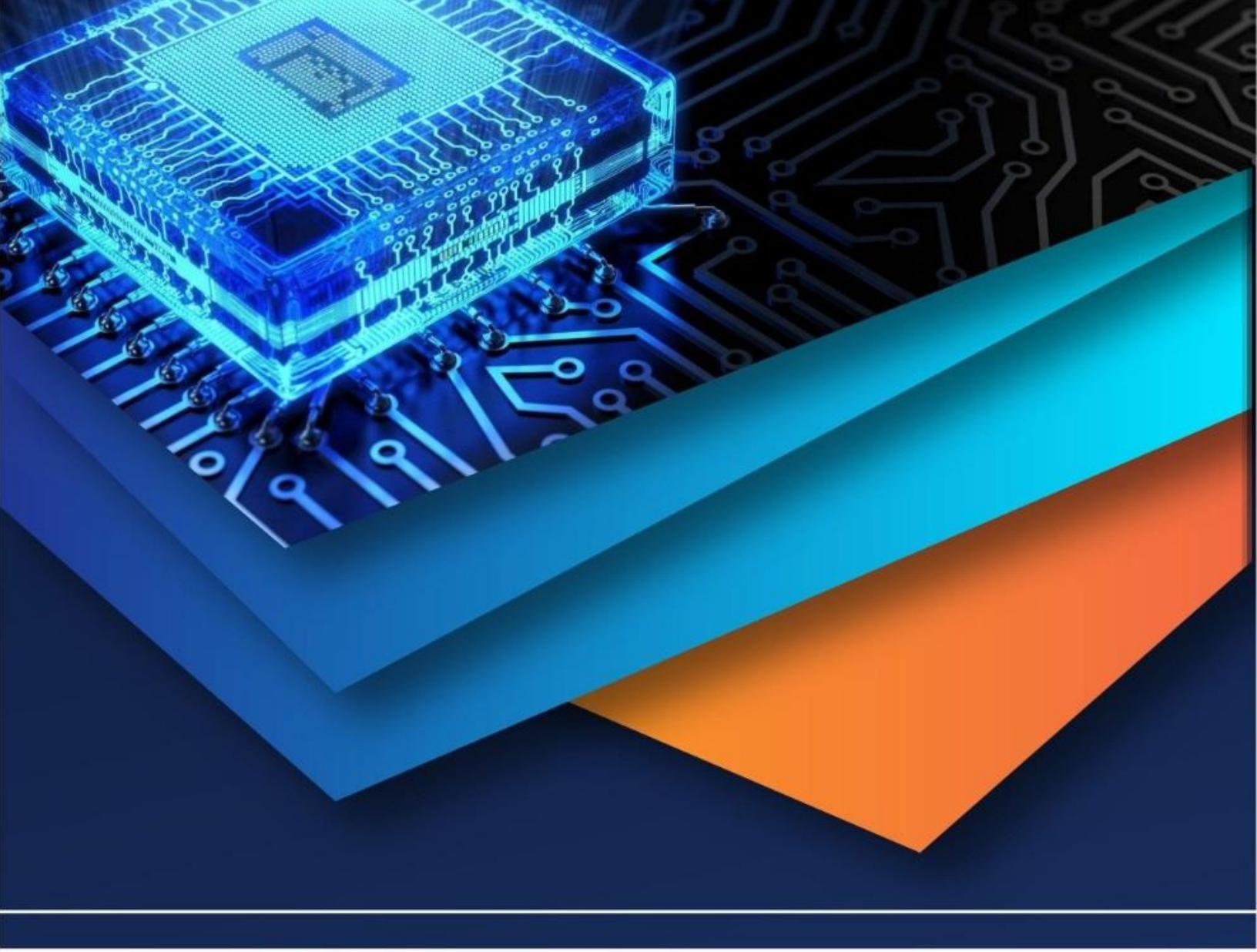
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