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Detection of Plant Leaf Diseases using Transfer Learning Techniques

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Abstract: *Agriculture is an essential field for meeting the country's increasing population's basic food needs. Meanwhile, the growth of grains and vegetables is essential for human nutrition and the global economy. Many farmers cultivate in distant places of the world, where reliable information and disease detection are lacking; yet, they rely on personal observation of grains and vegetables. Resulting in significant losses. This paper suggests an image processing based detection technique and preventive measures for plant leaf diseases in the agricultural field Using four popular convolutional neural network (CNN) models. such as the Xception model, VGG16, resNet-50, and one Custom CNN model. First, this technique is used to investigate the symptoms of diseased leaves using Kaggle datasets of several leaves. Then, using the image processing application and the Xception model, On dataset images, the feature extraction and classification procedure is used to find leaf diseases. In order to achieve better results, I used three additional CNN models: VGG16, Resnet50, and one custom CNN model.*

Keywords: Custom CNN model, Xception Model, VGG16 model, Resnet model, Plant disease

I. INTRODUCTION

The world's massive population is dependent on its massive economy. Similarly, economic growth is critical to a nation's economic growth and GDP. This economy's impact is entirely dependent on agriculture. However, The quantity and quality of grains and vegetables are driven by a range of agricultural conditions, Because of the various climates and conditions in various locations, These vegetables and cereals are exposed to numerous illnesses. The outcome is, Farmers in any nation suffer significant losses as a result of these diseases. Due to leaf disease, crop productivity is steadily declining.

However, using scientific knowledge and experience is a very effective method for identifying illness signs must be created. In this study captured leaf images are first collected from the Kaggle datasets.

In this study, we employ a variety of convolutional neural network (CNN) models, including Xception, Resnet50, VGG16, and a customized CNN model. These models distinguish between healthy and unhealthy leaves and identify various leaf diseases. The following contributions provide a general view of the proposed framework: First, we apply using image processing to analyze collections of leaves to find infection. Second, use the mentioned architectures to classify the processed leaf images. Finally, this article discusses the overall precision of the categorization of leaf diseases. We examine and create graphic designs for disease identification and prevention before we conclude.

II. LITERATURE SURVEY

Ashwin Dhakal et al. [1] built a model to recognize plant leaf diseases using feature extraction, segmentation, and classification of patterns of gathered leaves. Over the course of twenty epochs, the recovered features are fitted into the neural network. With the best performance in identifying the plant disease with 95.59 percent accuracy, many artificial neural network topologies are applied.

K. Muthukannan et al. [2] used a variety of neural network algorithms to identify spot diseases in leaves and classify them according to the types of diseased leaves. utilizing Radial Basis Function Networks (RBF), Learning Vector

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Quantization (LVQ), and Feed Forward Neural Networks (FFNN)to process the collection of form and texture data from the damaged leaf picture and detect unhealthy plants.

Malvika Ranjan et al. [3] article 'Detection and Classification of Leaf Disease using Artificial Neural Network' begins by snapping photos. From the segmentation output, color features like HSV features are extracted, the next step is to train the artificial neural network (ANN) by choosing the feature values that can successfully discriminate between healthy and pathological samples. Experimental results show that an ANN with a feature set improves classification performance with an accuracy of 80%.

Serawork Wallelign et al. [4] In the article study examines the viability of using CNN to identify plant diseases in leaf images that were captured in their natural habitat. To perform the classification of soybean plant diseases, CNN's capacity to recognize distinctive characteristics and classify plant illnesses from photos taken in the field is demonstrated by the implemented model, which obtains a classification accuracy of 94.32 percent. Manjunatha HT and AjitDanti.Arunkumar KL et al.[5][6][8] A Novel Approach for Detection and

Recognition of Traffic Signs for Automatic Driver Assistance System Under Cluttered Background" - Recent Trends on Image Processing and Pattern Recognition, Springer Nature Singapore, Pte Ltd.and "Segmentation of Traffic Sign Board in a cluttered background using Using Digital Image Processing.

H T Manjunatha, Arunkumar K L et al.[7][9] Classification of Vehicle Type on Indian Road Scene Based on Deep Learning

III. METHODOLOGY

In this study, a leaf disease detection system using four CNN architectures—including Xception, Resnet-50, VGG16, and a customized CNN model—is presented. To identify leaf diseases, the suggested technique regulates the subsequent sequential steps.

3.1 Image Acquisition

Image acquisition is the initial stage of the image processing process. This procedure is sometimes referred to as preprocessing in the context of images. The picture must be retrieved from a source, which is often hardware-based. Data collection from the public deposit is the initial phase. Take the image as an input for additional processing. Popular image domains are selected so that any format can be fed into the process (.bmp, .jpg, .gif). The primary goal is to detect and identify the disease class in the image. To customize it with various feature extractors that detect diseases in images.

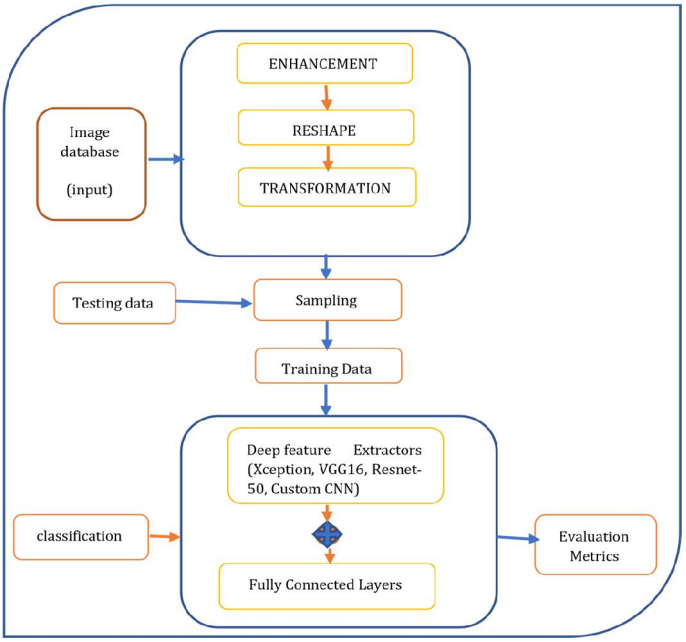

Fig 1. Block diagram of plant disease detection

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3.2 Image Pre-processing and Background Removal

This is the most important phase because it involves data quality assurance. During the image pre-processing phase, the image is converted to the desired colour format, resized to the desired size, and denoised. Because the images were captured in the field, They could have noise from wet spots, spores, and dust. The quality of the image is enhanced.

3.3 Image Segmentation

To obtain the infected region: The infected part of the leaf is identified as the region of interest. This is yet another critical step, as the entire analysis is dependent on the infected region identified by the segmentation process.

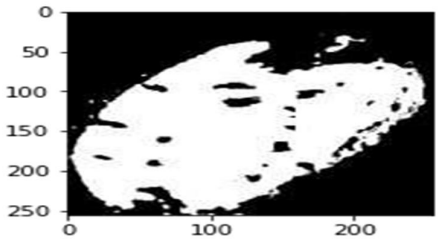

Fig 2: Segmented Image

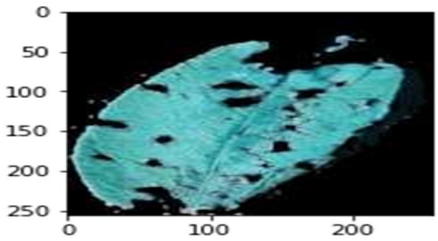

Fig 3:masked image

3.4 Extraction of Features from Images

The entropy of the image is extracted based on the obtained region of interest, which is the infected part of the leaf, and various image features such as standard deviation, mean of red, blue, and green channels.

3.5 Evaluate and Identification of the Affected Region

An efficient model is derived by comparing the extracted region of interests and features extracted from the image.

3.6 Processed Dataset Creation

The data processed in previous stages is processed, extracted, converted to csv file format, and saved. This saved data is then used for analysis purposes.

3.5Classification

The csv file's data is divided at random. The suggested model Xception model is trained using one-third of the split data.

3.6 Evaluation of Proposed Model

Based on the output of the classifier model, the evaluation metrics F1score, precision, recall, and accuracy will be computed.

3.7 Algorithm Steps

Workflow:

1. Load the images from the folder and resize and convert them to tensioners.
2. Construct a validation dataset using 0.3% of the total dataset.
3. Loading the data using Batches
4. Test the following CNN architecture:
    a. Xception model
    b. Combination of multilayer CNN with layers
    c. VGG16 using the transfer learning process
    d. Resnet-50 through the Transfer learning process
5. Select the device and upload the data to the device i.e. (GPU)
6. Fine tuning with transfer learning
7. Train the model and evaluate the model on valid (test) data
8. Save the model train

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IV. RESULTS AND DISCUSSIONS

Since we have got highest Accuracy in Xception model so we have considered this model as our main model for this paper other three models (Resnet-50, VGG16, custom CNN) are only to compare those models with our Xception model while predicting the plant disease .

4.1 Xception Model

We considered this model as our base model. This is a transfer learning technique this model achieved good accuracy on plant village dataset which is having 15 classes and it is taken from Kaggle website. Xception model is a Transfer learning Technique where it is finetuned with other layers for detection of plant disease before finetuning we achieved 90% accuracy for plant village dataset which is having 15 classes and after finetuning model achieved 97.90% accuracy so Xception model outperformed other three models which we have mentioned in the table 1 below.

```
Loading images ...
Processing Pepper__bell___Bacterial_spot
Processing Pepper__bell___healthy
Processing Potato___Early_blight
Processing Potato___healthy
Processing Potato___Late_blight
Processing Tomato_Bacterial_spot
Processing Tomato_Early_blight
Processing Tomato_healthy
Processing Tomato_Late_blight
Processing Tomato_Leaf_Mold
Processing Tomato_Septoria_leaf_spot
Processing Tomato_Spider_mites_Two_spotted_spider_mite
Processing Tomato__Target_Spot
Processing Tomato__Tomato_mosaic_virus
Processing Tomato__Tomato_YellowLeaf__Curl_Virus
Image loading completed
```

Figure 4: Dataset Description

These are the 15 classes that make up the modules, as seen in figure 3. It is evident that there is tomato, potato, and pepper. Additionally, all of the plant leaves described above fall under the category of being healthy. analysis of categorization methods for the 54305 input leaf photos. Of these, 1,000 are affected by early blight, 1,000 by late blight, and so forth. There are also 997 affected by bacterial spot.

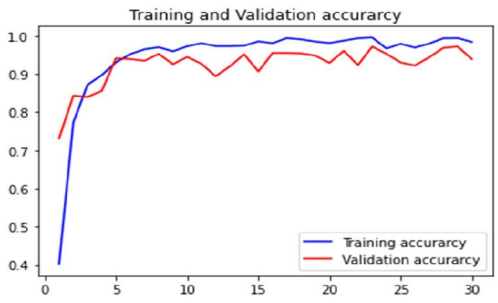

Fig 4: Validation and Training Accuracy

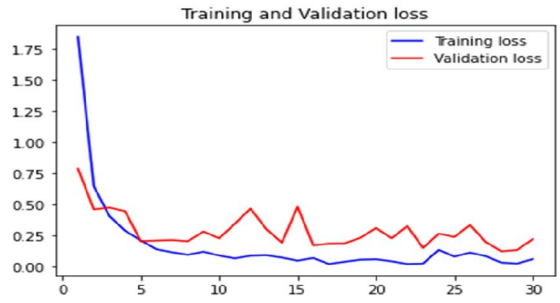

Fig 5: Validation and Training loss

The above graph (fig3) depicts how the Xception model performed for the plant Village datasets. When developing the model, we gave 30 ephochs to train the model, so this graph depicts how training and validation data accuracy fluctuated for each iteration.

Above figure4 shows that how Xception model performed for the plant Village datasets while building the model and we have used categorical_crossentropy loss function .so this graph shows loss function perfor ms on training and validation data for each iteration.

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4.2 Comparison between Models:

Model	Accuracy (%)	Precision	Recall	F1-score
Xception	97.90	0.95	0.93	0.94
VGG16	89.91	0.75	0.60	0.62
ResNet-50	85.57	0.80	0.75	0.68
Custom CNN	80.30	0.80	0.70	0.67

Table 1: Details of evaluation metrics obtained for the CNN models implemented

In the above table2 Xception model achieved the highest accuracy for our 15 classes plant village dataset for this reason we have considered Xception model as our base model to predict the plant disease.

V. CONCLUSION

Using CNN and the transfer learning approach, this study recommended a practical diagnosis tool for tomato, potato, and pepper plant leaf diseases. To investigate the signs of damaged leaves, the image processing strategy is used to Kaggle data sets of potato, pepper, and tomato leaves. This is done by using techniques including pre-processing, augmentation, and data extraction. In addition, four architectures (Custom CNN, Xception, Resnet-50, VGG16) are used in the classification of leaf images as early potato blight, late potato blight, early tomato blight, and late tomato blight, among other things. The Xception model outperformed other models with a 97 percent accuracy rate. As a result, we considered the Xception model or a pretrained Xception model that works well with the plant village dataset to identify the plant disease.

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