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Leaf Disease Identification Using DeepLearning

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Abstract— Tomato is one of the most important agricultural commodities in the world with a number of cuisines scattered across the globe, which are incomplete without it. In developing countries like India, tomato has spurred agriculture driven growth in the past century, when export of agricultural produce was the major source of foreign exchange. At times, the prices face a blow from the demand side, while at times facing drasticconditions on the supply side, owing to which, the pricesof the commodity have seen a drastic fall. In such years,farmers often cannot afford the services of agricultural consultants for tasks such as detection of leaf diseases and addressing them at the earliest. The solution we haveproposed, is a low cost system that uses image processing to detect leaf diseases in the leaves of tomato plants to make things easier for both the farmers as well as consumers, since this would balance the prices at a median price, which is both profit-earning for farmers aswell as affordable to the consumers at all times of the year.

In this project, the affected leaves are captures as images using a camera. These images are then processed further using various methods and the dominant features are extracted from them using various methods.Comparison of the features is done using various algorithms that detect the variance in color and its dominance in the recorded samples. This will help in faster and cost effective addressing of such diseases.

Index Terms— Leaf disease, machine learning, deep learning, depth wise convolution, point wise convolution.

I. INTRODUCTION

The condition of a tomato leaf is an important aspect that affects the yield of tomato, both in terms of quantity as well as quality. Tomato leaf disease detection is an image processing based system that uses visual cues on the leaf surface to know the disease. Many approaches have been developed that use cameras and computer vision algorithms to study the tomato leaves.

Earlier, complex computer programs to identify such diseases were never materialized or brought into the mainstream owing to the affordability of agricultural consultants and advisors; as well as the complexity and non-user-friendliness of the development environments. However, as the platforms have become more user-friendly than ever, why shouldn't this decision be revisited? When a computer is taughtto simply recognize leaf diseases to begin with- suggesting remedial measures for the same can be easily incorporated. Since diseases affect the appearance of a leaf, which can be perceived by vision, using image processing is a good approach. Unlike inother applications where a conflict of understanding may hinder project development- the presence of a particular undesirable trait or color on a 'Tomato leaf'has a universal bearing across the tomato producing world.

II. PROBLEM STATEMENT

To design and develop an efficient and automaticsystem to detect diseases in tomato leaf images, using image processing, in order to minimize professional interference and thus reduce the expenditure involved in the tomato growing industry.

Input: Acquired Tomato Leaf Image Process: Preprocessing: The image is first pre-processed to enhance the visible characteristics and make classification of diseases easier. We use the median filter to remove noise from the image, use basic globalthresholding to remove the background, and then, a high pass filter to amplify the finer details in theimage.

Feature Extraction: Histogram Orientation Gradientis used to extract the features from the image. This produces a histogram of angles versus their frequency in the image, which is used for further classification

Classification: We use CNN to classify the disease observed in the images. Moreover, we will be comparing the results of various CNN architectures tocheck which is performing better.

Output: The name, nature and cause of the leaf disease detected and the remedial measures.

III. MATERIALS AND METHODS

A. System Architecture

A System architecture is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system, organizedin a way that supports reasoning about the structures

The figure 3.1 shows the system architecture for the proposed method. Here we can see that the leaf image input is fed into the leaf disease detection system, in which it is pre-processed, then features are extracted. Then the extracted features are fed to softmax classifier which is the last part of CNN.

The input image is pre-processed and converted to grey scale image to find the Threshold value based oninput image. Based on Threshold value further image sharpening is done, then further process is carried out.

The proposed system has the following steps for detection of disease.

1. RGB to grey scale
2. Noise Removal
3. Thresholding
4. Image Sharpening
5. Feature Extraction and Classification

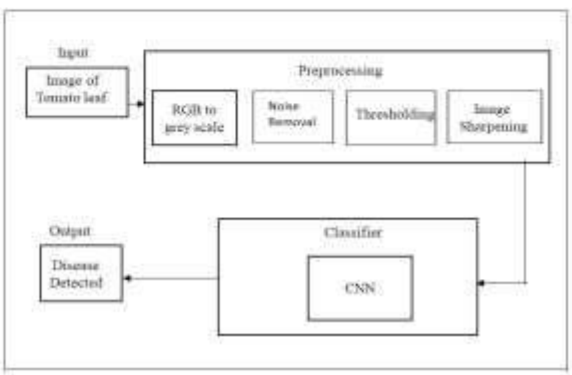

Figure 3.1: Architectural Diagram of the Proposed System using CNN.

B. Convolutional Neural Networks

In deep learning, a convolutional neural network (CNN, or ConvNet) is a class of deep neural network most commonly applied to analyzing visual imagery. They are also known as shift invariant or space invariant artificial neural networks (SIANN), based ontheir shared-weights architecture and translation invariance characteristics. They have applications in mage recommender systems, image classification, medical image analysis, natural language processing, brain-computer interfaces, and financial time series.

CNNs are regularized versions of multilayer perceptron's. Multilayer perceptron's usually mean fully connected networks, that is, each neuron in one layer is connected to all neurons in the next layer. The "fully-connectedness" of these networks makes them prone to over fitting data. Typical ways of regularization include adding some form of magnitudemeasurement of weights to the loss function. CNNs take a different approach towards regularization: they take advantage of the hierarchical pattern in data and assemble more complex patterns using smaller and simpler patterns. Therefore, on the scale of connectedness and complexity, CNNs are on the lower extreme.

C. Data Flow Diagram of Pre-processing Module

Input image through camera is captured and it can be used to store as dataset for training or as input image to detect the disease. The image is captured and stored in any supported format specified by the device.

As shown in the figure 3.2 initially the set of captured images are stored in a temporary file in OpenCV. The storage is linked to the file set account from which thedata is accessed. The obtained RGB image isconverted in to gray scale image to reduce complexity.

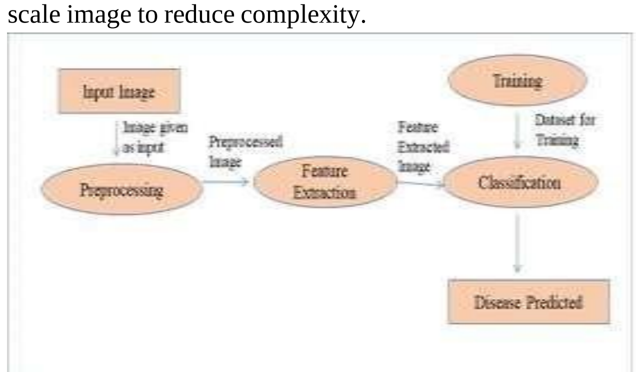

Figure 3.2: Data Flow Diagram of Tomato LeafDisease Detection.

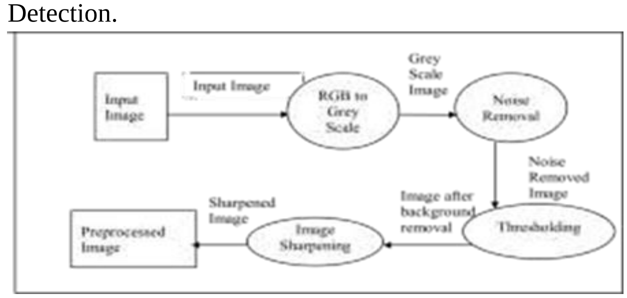

Figure 3.3: Data Flow Diagram for pre-processing module.

D. DETAILED DESIGN

A detail design is the process of each individual module which is completed in the earlier stage thanimplementation. It is the second phase of the projectfirst is to design phase and second phase is individual design of each phase

options. It saves more time and another plus point is to make implementation easier.
Detailed design is the process of refining and expanding the preliminary design of a system or component to the extent that the design is sufficiently complete to begin implementation. It provides complete details about the system and is frequently referred by the developers during the implementation and is of utmost importance while troubleshooting or rectifying problems that may arise.

Structural Chart Diagram

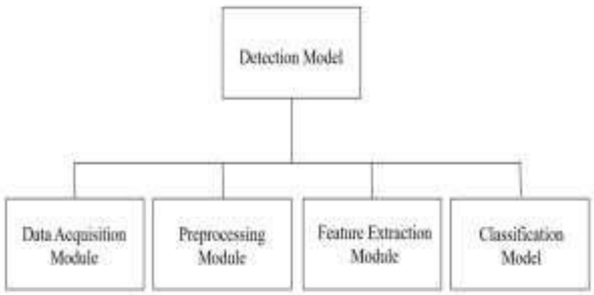

Figure 3.4 Structural Chart of the DiseaseDetection Model.

E. Typical CNN Architecture
CNN architecture is inspired by the organization and functionality of the visual cortex and designed to mimic the connectivity pattern of neurons within the human brain. The neurons within a CNN are split into a three-dimensional structure, with each set of neurons analyzing a small region or feature ofthe image.
In other words, each group of neurons specializes in identifying one part of the image. CNNs use the predictions from the layers to produce a final output that presents a vector weights over the input generated by the feature analysis to predict an accurate label. Output layer-generates the final probabilities to determine a class for the image. Figure3.5 represents the Layers in CNN.

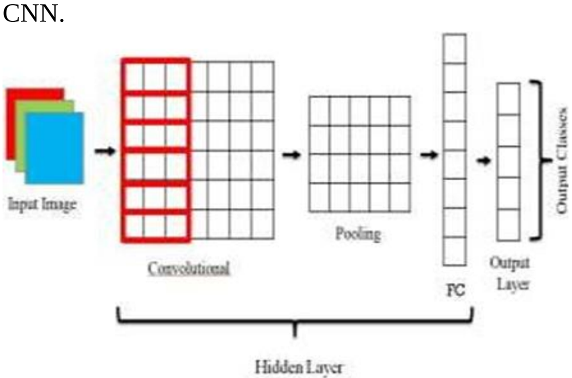

Figure 3.6: Typical CNN Architecture.

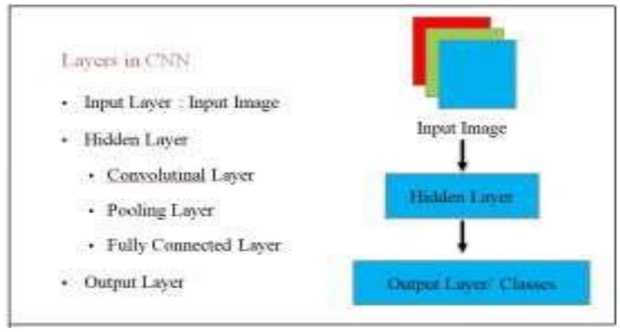

Figure 3.6: Layers in CNN.

IV. IMPLEMENTATION

Implementation is the platform where the projectworking is demonstrated. In implementation the system drives for real operations. Every consequence completed by the project will be abundant, if processes are accurately executed according to plan carried out. Implementation Requirements To implement Tomato Leaf Disease Detection using Convolutional Neural Network, software's used are Language used to code the project is Python. Operating System- Windows 10.
A. Graphical Inferences
Prior to having a literary conclusion, as an understanding of the results we have seen in the implementation of the three CNN architectures, namely Mobile Net, VGG and Inception, let us havea look at the accuracy and loss graphs generated by each of these methods, before we derive inferences.
1.Accuracy Graph
It is a plot of accuracy on the y-axis versus epoch on the x-axis, with plots for both training and test data. Accuracy should increase with epoch values for a better model.
2.Loss Graph
It is a plot of loss, in terms of features that are dropped from consideration on the y-axis versus epoch on the x-axis, with plots for both training and test data. Loss should decrease with epoch for a better model.

Graphs for Inception Model

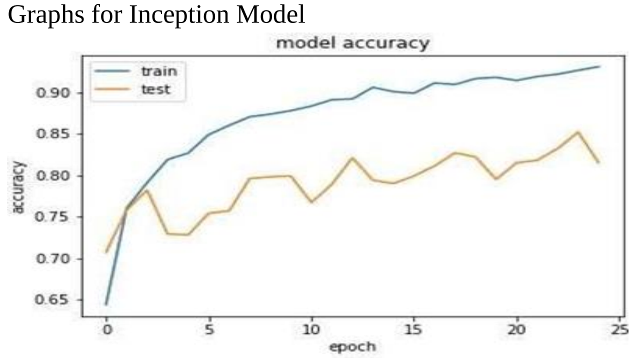

Figure 4.1: Inception Accuracy Graph.

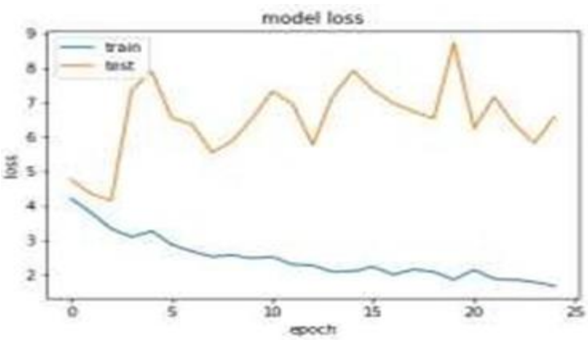

Figure 4.2: Inception Loss Graph.

From the graphs in Figure 4.1 and 4.2, we see that the test data does fit accurately around the 85% mark as the training data as this model is one of the most powerful ones.

Graphs for VGG-16 Model

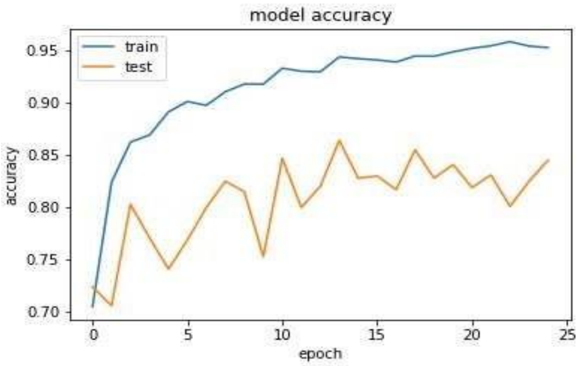

Figure 4.3: VGG-16 Accuracy Graph.

V. CONCLUSION

VGG is by far the best model for this purpose with better accuracy rates of over 80%- though it is more compute intense. For more primitive devices that have lesser processor speeds, the Mobile Net model might be better. Even with lower accuracy rates, it offers an efficient experience. In this project work, a very simple but powerful method is used to detect tomato leaf diseases using various CNN architectures. In this project we focus on different methods for prediction and classification of leaf diseases. Also, in proposed methodology we discuss different methods of image processing techniques. We can modify available algorithms so as to obtain good accuracy while classifying leaves. Accuracy and early detection of these diseases will help farmers to take early precautions and prevent huge losses. The method used will give the name of the disease as the class to which the image belongs as the result. This project also helps farmers to address the disease by providing them witha small amount of information about the disease. In the implemented system the results were very accurate. One of important enhancement in this project is that it can be implemented by government authorities over alarge span of farms to check if certain diseases have become more dominant over the others and are proving difficult to tame.

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