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Plant Disease Detection using Machine Learning

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Abstract - —*The identification and detection of diseases of plants is one of the main points which determine the loss of the yield of crop production and agriculture. The studies of plant disease are the study of any visible points in any part of the plant which helps us differentiate between two plants, technically any spots or color shades. The sustainability of the plant is one of the key points that is for agricultural development. The identification of plant diseases is very difficult to get right. The identification of the disease requires lots of work and expertise, lots of knowledge in the field of plants and the studies of the detection of those diseases. Hence, image processing is used for the detection of plant diseases. The Detection of diseases follows the methods of image acquisition, image extraction, image segmentation, and image pre-processing.*

In this paper we will show the detection of diseases of plants by getting their images of leaves, stems and fruits. We will also discuss the use of image extraction, and image pre-processing which will be used for making this project.

Key-Words: segmentation, pre-processing, extraction, identification, plants

1. INTRODUCTION

The problem of efficient plant disease protection is closely related to the problems of sustainable agriculture and climate change In India, Farmers have a great diversity of crops. Various pathogens are present in the environment which severely affects the crops and the soil in which the plant is planted, thereby affecting the production of crops .Various disease are observed on the plants and crops .The main identification of the affected plant or crop are its leaves. The various colored spots and patterns on the leaf are very useful in detecting the disease.

The past scenario for plant disease detection involved direct eye observation, remembering the particular set of disease as per the climate, season etc. These methods were indeed inaccurate and very time consuming. The current methods of plant disease detection involved various laboratory tests, skilled people, well equipped laboratories etc. These things are not available everywhere especially in remote areas. Detection of disease through some automatic technique is helpful because it reduces an oversized work of watching in huge farms of crops, and at terribly early stage itself it detects the symptoms of diseases means that after they seem on plant leaves. There are several ways to detect plant pathologies. Some diseases do not have any visible symptoms, or the effect becomes noticeable too late to act, and in those situations, a sophisticated analysis is obligatory. However, most diseases generate some kind of manifestation in the visible spectrum, so the naked eye examination of a trained professional is the prime technique adopted in practice for plant disease detection. Variations in symptoms indicated by diseased plants may lead to an improper diagnosis since amateur gardeners and hobbyists could have more difficulties determining it than a professional plant pathologist. An automated system designed to help identify plant diseases by the plant's appearance and visual symptoms could be of great help to amateurs in the gardening process and also trained professionals as a verification system in disease diagnostics. Advances in computer vision present an opportunity to expand and enhance the practice of precise plant protection and extend the market of computer vision applications in the field of precision agriculture.

2. REQUIREMENTS

2.1 Hardware Components

2.1.1 Android Smart Phone

Nowadays smartphones are used for multipurpose. Smartphones are handy and provide long-lasting battery. Warp-speed processing, Crystal-clear display, great camera, etc. In this project, we have used an android app that uses the camera of the phone and clicks the picture then give us the information about the plant like its name and confidence level

Fig -1: Smartphone

2.1.2 Graphics Processing Unit

A graphics processing unit is a specialized electronic circuit designed to rapidly manipulate alter memory to accelerate the creation of images in a frame buffer intended for output to a display device.GPU are used in embedded systems, mobile phones, personal computers and workstations Modern GPU are very efficient at manipulating computer graphics and image processing

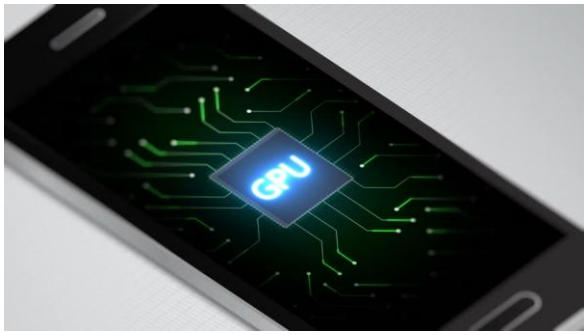

Fig -2: GPU

2.2 Software component

2.2.1 Android Studio

There are multiple methods to create android applications which have taken a huge rise in popularity in recent times. Of these methods Android Studio is a native android application builder which is used. It is used for creating android applications which require a simple output. The coding in Android Studio is done in java but kotlin is newly introduced. We have used kotlin for this application as it reduces the lines of codes and simplifies the application. If this application would have been written in java, the run time would be quite slow and gradle building would take a long time.

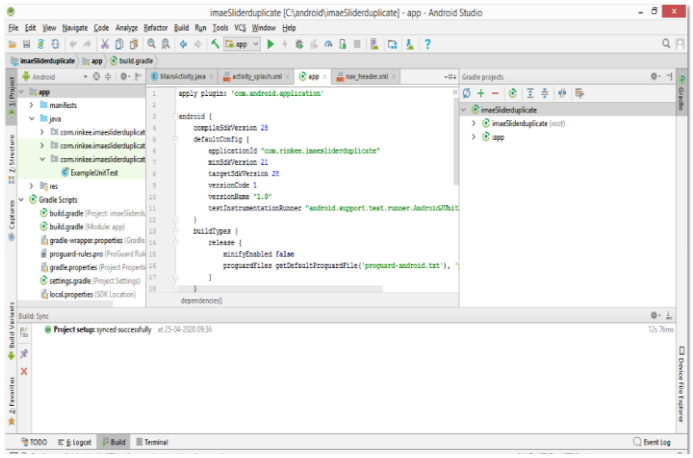

Fig -3: Android Studio

2.2.3 Android app

An Android app is a software application running on the Android platform. Because the Android platform is built for mobile devices, a typical Android app is designed for a smartphone or a tablet PC running on the Android OS.

We have made an android app to distinguish the leaf disease from other. The name of the app is “Leaf Detection”. In this app first, the screen will appear with several buttons then if we click on the camera it will click the photo of the leaf and it will show the name of leaf and the confidence level of that leaf. The app is already trained with images. When an app is place in front of the leaf then an image of is captured through the camera and this captured image is compared with the data which is already present in our database. After that leaf will get identified whether it is healthy or not and accordingly app identifies the name of the leaf.

2.2.4 Keras

Keras is a high-level Python neural networks library that runs on top of either TensorFlow or Theano. There are other high level Python neural networks libraries that can be used on top of TensorFlow, such as TF-Slim, although these are less developed simplifies the codes used in tensorflow by making use of a smaller code base so that the code length will reduce and make sure that the processing will run smoothly. Keras is used for a graphical representation of the models which helps to understand the structure of the model. Auto Keras, a library based on keras, has also gained popularity and can be used to make it quicker to get results

2.2.5 Tensorflowlite

Tensorflow lite is a deep learning framework and is based on the tensorflow framework. It is used to reduce the size of a normally huge tensorflow model so that it can be used in modular devices such as mobile phones. We can use tensorflow lite to access the model with android studio. It is

a complex procedure and is used to access a minimal reduction algorithm of the model

2.2.6 CNN

Convolutional Neural Networks are a complex neural network chain which work to get the features of an image from a dataset which is trained and classify them to get the required output. It trains the neural networks by using the dataset images and changing them to numerical values.

The main advantage of CNN compared to its predecessors is that it automatically detects the important features without any human supervision....ConvNets are more powerful than machine learning algorithms and are also computationally efficient. These numerical values are then put into numerical arrays based on their categorized characteristics. These arrays are then put into different nodes in the network and passed through multiple iterations based on the input given. The CNN models are used for geographical classification in multiple companies which require data to be classified in a quick and secure way it almost acts like a filter removing dust and separates the features of the images.

2.2.7 Classification

Feature classification is used for plant disease detection. The diseased features are removed from the plant and classified with the healthy leaf image. When the leaf is healthy and there is no classification the results are shown as healthy and when there is a disease which when grey scaled shows black spots, it classifies them so they are shown as which disease they are and the confidence of the classification. Classification takes place between two numerical arrays. If the numerical arrays match, then it is a healthy or a diseased leaf, depending upon the dataset provided. Classification is a simple but relevant procedure which gives a proper result and is used in plant disease detection.

3. Flow of system

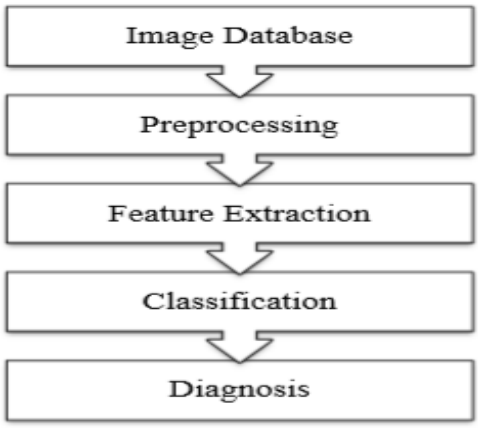

Fig -4: Flow of system

Fig -5: Android app

4. Class Diagram

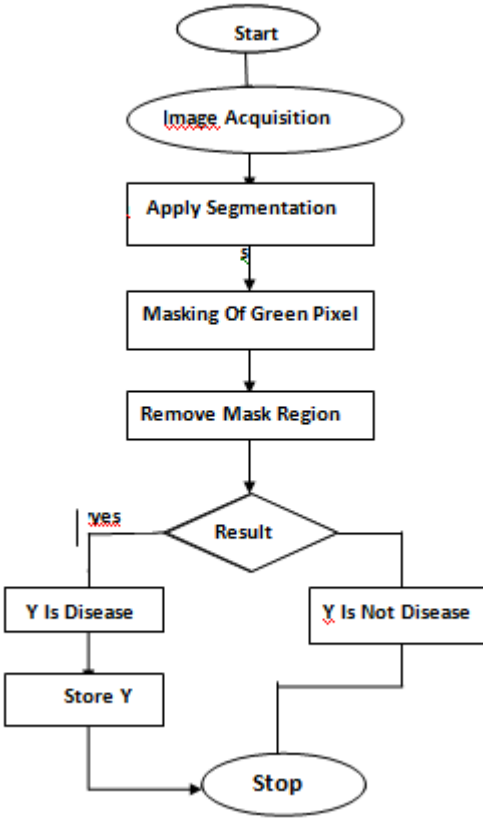

Fig -6: Class Diagram

5. Block Diagram

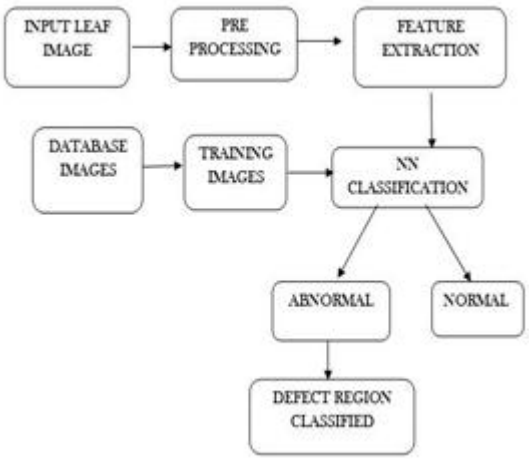

Fig -7:Block diagram

6. Implementation Methodology

Our proposed system is an application based software. We have an android based software which simply takes the image of the plant and uploads it to the mobile device. Then this image is sent through a Convolutional Neural network which encodes this image into a numerical array and classifies it with the other numerical arrays in the model. The model is a tensorflow model which is made into a tensorflow lite model because of the large size of the normal tensorflow model. This model helps classify the uploaded image numerical value to the dataset values. When a numerical array matches it calculates the confidence and displays the value which has the highest confidence. In this way, we can ensure that we always have the highest confidence value showing in the results. The proposed methodology is as follows:

Dataset:

Plant Village dataset consists of 54,306 images of different plant leaves which are divided into 18 classes. The dataset consists of 13 types of plant species and 26 types of plant diseases. The dataset contains both healthy and diseased crop images .The images cover 14 species of crops, including: apple, blueberry, cherry, grape, orange, peach, pepper, potato, raspberry, soy, squash, strawberry and tomato. Each class consists of two fields i.e. name of the plant and name of the diseases .Each of the images are resized and segmented for preprocessing and further classification.

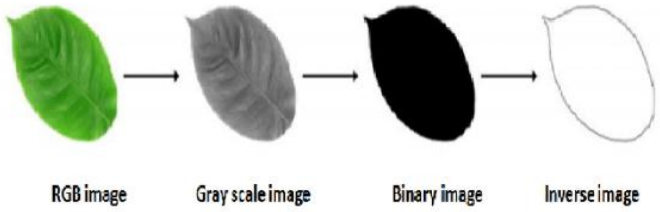

Fig -8: Preprocessing of Images

Image Acquisition:

Basically this step consists of taking in the leaf image from the mobile device. The application uses a camera module which enables the user to take images. Since the images are taken from different mobile devices hence, the images obtained may be of different qualities. This may affect the accuracy of the system. Hence, to avoid this we send the image for preprocessing where the image quality is improved for further process.

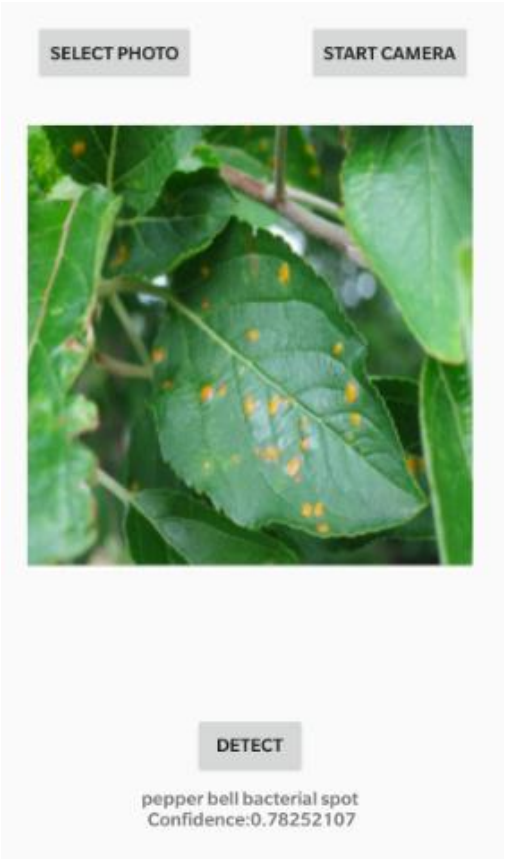

Fig 9. App screenshot

Pre-processing of the Images:

Pre-processing is a very important step in CNN as the images in the dataset may have some inconsistency which may affect the accuracy of the system. The images in the dataset have noise and non-uniform lighting which needs to be rectified in this step. We do so by applying segmentation on

the images to get rid of uneven backgrounds. Through segmentation we extract the relevant part of the images which in this case are the image of leaves. Hence, after segmentation we have the images of leaves with black background. Now to rectify the non-uniform lighting we convert the images to grayscale images and send it for further processing.

Feature Extraction:

As we get the greyscale images from the previous step, we take the image and convert it into reduced variables. Basically each pixel of the images are taken and are converted into matrix for performing convolutions. The process runs across all the pixels where the convolution matrix is simply multiplied with each pixel matrix. Also we mention the number of strides which refers to the shifting of pixel matrix. Once all the values are obtained by multiplication, we then perform Pooling on the matrix. Here we are using Max pooling for our system for better accuracy and extraction of features .Both the process i.e. Convolution and Pooling form an epoch. Now to improve the system accuracy we perform a number of epochs but this may cause to increase in the number of parameters. Hence, through following these steps we get to extract unique features from the images. These unique features are then sent for further processes.

Disease detection and classification:

Detection of disease is performed in two steps i.e. detection of the type of crop and detection of type of disease. This takes place with the help of Convolutional Neural Network .We will be using Transfer Learning for building the Model. It is a technique where the pertained models are used to create the current models. Classification also acts as fully connected classifiers which are formed using various learnings done by the model. We do the following by flattening of images which convert the pooled images to single dimension vectors. Once the images are converted to the vectors it gets quite easy to classify the images. Through the trained model we get certain numerical values with respect to various classes. When the leaf is healthy and there is no classification the results are shown as healthy and when there is a disease which when grey scaled shows black spots, it classifies them so they are shown as which disease they are and the confidence of the classification. Classification takes place between two numerical arrays. If the numerical arrays match, then it is a healthy or a diseased leaf, depending upon the dataset provided. Classification is a simple but relevant procedure which gives a proper result and is used in plant disease detection. Disease

Fig -10: Disease of detection

7. Acquired Results

The results acquired for this system range from three different categories. The Numerical arrays in the neural network. The features acquired from the network outputs and the layer outputs we get when the features are classified. These results are acquired in different stages of the system. First we get the numerical array from the neural network. Then the features of the images and then the layers are acquired.

7.1.1 Numerical Array

As neural networks generally use a mathematical function to classify the features and that computerized inputs are based on numbers, we have to encode the images to numerical arrays. Each image has a different numerical array based on their hex values and the features it has. The Numerical values are stored separately while training the model. The trained model is then tested with another image which is encoded into a numerical array and then sent through the network. The output is then decoded again to get the image.

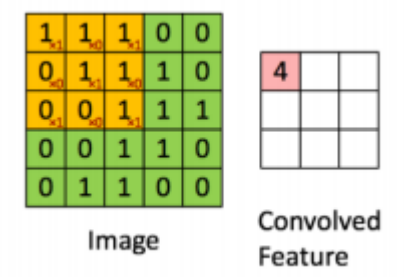

Fig -11: Convolution Process

7.1.2 Features

The features of the plants range from color, shape and disease type. This can make a million odd diseases which the model has to characterize and put in the system. As the features are put into various categories the images are decoded to get the next result, which is the layered output.

7.1.3 Layer Outputs

The layer outputs are different layers of the detection of the disease. These can be the grayscale images and the rgb of the images. These help in separating different colored features of the leaves and make sure they are categorized into multiple different categories. It also makes sure that the user can understand where the disease is located and the numerical value can easily make the white and black images into 1 and 0.

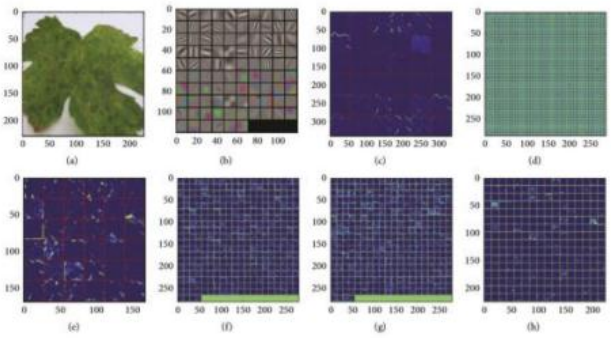

Fig -12: Convolution and Pooling

8. Future Scope

Since currently the system is trained using Plant Village dataset, the model is trained to detect only 26 types of plant diseases. We propose to train the system with much more data of various other plants and diseases to further increase the scope of the system. By adding images of many other plants, it will help in extracting many more features of the plants which certainly help in improving the accuracy of the system.

The users using the system may also contribute to the system by capturing different types of plant images which can be added to the dataset. This dataset can be further used to build better models Also the may be improved in terms of accuracy by implementation of better algorithms in the coming future. We also propose to provide certain remedies for the crop diseases to the user by analyzing the diseases. This will certainly help the users to avoid such diseases in the future. Also the remedies will help the user to get rid of the diseases hence, improving their yield.

9. CONCLUSION

In this paper the Deep Learning algorithm i.e. Convolutional Neural Network is used to with a goal to detect the diseases in the crops. The model is basically tested on some types of plant species with some types of plant diseases. The model was made using Tensor flow and Keras frameworks and the system is implemented on Android. The overall system results show that the Mobile Net model works better as compared to the other models and provide better accuracy in detecting the diseases .As an extension to the project the number of classes of plants and its diseases will be increased .Also the model will be further improved by increasing the parameters for training and test.

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