IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Impact Factor: 6.252

Volume 2, Issue 3, April 2022

Plants Disease Detection System

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Abstract: *As the world's population grows, so does the demand for food. In such conditions, plant diseases become a huge threat to agricultural products, resulting in severe effects for farmers. To avoid this, plant diseases must be discovered and treated as soon as possible to avoid significant repercussions. The current manual approach of detecting plant diseases is time-consuming and expensive for farmers, and it can also result in wrong diagnosis. As a result, we can employ technologies such as image processing and deep learning to successfully detect plant diseases in their early stages.*

Keywords: Plant Disease, Image Processing, Image Acquisition, Segmentation, Feature Extraction, Classification

I. Introduction

Plant diseases are one of the leading causes of agricultural productivity and economic losses. Properly identifying sickness is a difficult undertaking that necessitates experience. Frequently, diseases or their symptoms, such as coloured spots or streaks, can be seen on plant leaves. Microbes such as fungi, bacteria, and viruses are commonly responsible for plant illnesses. Because of the cause or ethology of the plant disease, there is a wide range of indications and symptoms.

Farmers currently contact plant doctors for plant disease cures, which is time consuming and frequently requires physical labour. Farmers are being charged exorbitant consultation costs that they cannot pay. To address these issues, we developed a plant detection system based on Convolutional Neural Networks that predicts plant disease based on the farmer's photograph. This proposed work is less time-consuming, free, and accurate, making it suitable for application in real-time.

II. Literature Review

In their study [1,] Nilam Bhise et al. discuss the identification and detection of plant diseases as one of the primary factors that determine the loss or gain of crop production and agriculture yield. Plant disease research is the investigation of any visible points in any portion of the plant that aid in the differentiation of two plants, technically any spots or colour shades. So, in this paper, the Convolutional Neural Network, a Deep Learning technique, is utilised to detect diseases in crops. The model is primarily tested on a variety of plant species as well as a variety of plant diseases. TensorFlow and the Keras framework were used to create the model, and the system was built 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.

Malvika Ranjan et al. in the paper[2] ―Detection and Classification of leaf disease using Artificial Neural Network" proposed an approach to detect diseases in plant utilizing the captured image of the diseased leaf. Artificial Neural Network (ANN) is trained by properly choosing feature values to distinguish diseased plants and healthy samples. The ANN model achieves an accuracy of 80%.

Sammy V Milante In his paper[3], he uses CNN architecture to classify and identify diseases. The study's methodology consists of three main stages: data acquisition, data preprocessing, and image classification. Input Dataset, Image Acquisition, Image Pre-processing, and Classification are the steps used in this methodology. During the model's training, 75 epochs were used to attain a 96.5 percent accuracy rate. When examining random photos of plant kinds and diseases, the model attained a maximum accuracy rate of 100 percent.

Md. Arifur Rahman[4] is primarily interested in developing a better segmentation technique that combines thresholding and morphological procedures. They employed a deep neural network for classification. Enhancement, segmentation, feature extraction, and classification are the four stages of this approach. In the Plant Village database, their proposed technique has a 99.25 percent accuracy rate.

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Emaneul Cortes developed a strategy to identify plant disease using Generative Adversarial Networks in his paper "Plant disease detection using CNN and GAN" [5]. For accurate feature extraction and output mapping, background segmentation is required. Although utilising Gans to classify diseases in plants appears to have promise, segmenting depending on background did not enhance accuracy.

In his paper[6], S.Santhana Hari discusses the use of leaf images to detect plant illness. A deep learning algorithm is used to identify diseases. All of the classifications were done using photographs of the crop's leaf, which included both healthy and afflicted leaves. The accuracy of this model is approximately 96.3 percent. For the grading of plant species, a deeper network design is used. Their outcome was 86.2 percent accuracy, which is less accurate.

III. Methodology

Before you begin to format your paper, first write and save the content as a separate text file. Complete all content and organizational editing before formatting. Please note sections A-D below for more information on proofreading, spelling and grammar.

3.1 Backend Model

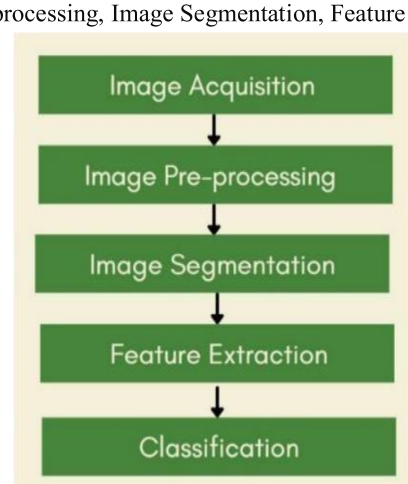
The proposed Convolutional Neural Network model is built using Python with TensorFlow and Keras library. Both TensorFlow and Keras are specially used to handle deep learning networks. Keras works as an interface for TensorFlow library.

3.2 Frontend

The backend model has to be made accessible to the users by providing a suitable interface for them to interact with. We have made use of the Flask framework, which is written in Python. It is simple framework which helps us to build web-based applications. The image submitted by the user for consultation, is converted into proper format(arrays) and send to the backend for classification using the Flask API. These requests and responses are communicated using AJAX. The frontend webpages are built using simple HTML and CSS.

3.3 Implementation

In our proposed work, we aim to detect and classify the plant diseases using the concept of Convolutional Neural Networks (CNN). Convolutional Neural Networks is a class of artificial neural network that works on the concept of hidden layers and is most widely used to in image processing and recognition. The basic framework or flow of our project consists of 5 steps, namely: Image Acquisition, Image Pre-processing, Image Segmentation, Feature Extraction and Classification.



3.4 Image Acquisition

The first step of image classification is image acquisition. The dataset which is selected to build the model plays a very important role in the result observed from it. In image-oriented datasets, the images must be properly labelled, and it must be made sure that no such images exist which do not have labels.

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For our CNN model we have made use of Plant Village dataset. This dataset has a collection of 15 directories of healthy and diseased plant leaves of 3 different plants namely Bell Pepper, Potato and Tomato. With a total of 20,639 images, this dataset houses the following directories of plant leaves:

- Pepper Bell Bacterial spot
- Pepper bell healthy
- Potato Early blight
- Potato Late blight
- Potato healthy
- Tomato Bacterial spot
- Tomato Early blight
- Tomato Late blight
- Tomato Leaf Mold
- Tomato Septoria leaf spot
- Tomato Spider mites Two spotted spider mite
- Tomato Target Spot
- Tomato Yellow Leaf Curl Virus
- Tomato mosaic virus
- Tomato healthy

Using this activation function helps the model to learn faster and perform better because it does activate all the neurons at once

3.5 Max-Pooling Layers

In CNN, usually every activation function layer is followed by a pooling layer. Pooling layers are used to reduce the dimensions of feature maps. They are 3 types of pooling – average-pooling, max-pooling and global-pooling. We have made use of max-pooling technique because it enhances the features of the pictures by taking the utmost of the values present therein region. At the top of this operation, we obtain the foremost prominent features of the image. This step helps in avoiding over-fitting and also reduces noise distortion.

Other than these 2 techniques used for feature extraction of a picture, dropout layer is employed to scale back over-fitting of the model, where the neurons are dropped randomly. Flatten layer is used to convert the output into one long feature vector which is given as input into the next layer.

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3.6 Image Pre-processing

The images which are acquired cannot be directly fed into the Convolutional Neural Network. Since, the computer does not understand anything other than binary numbers, the images also must be converted into machine understandable format. This is done by converting the pictures into array format. The images of the dataset are converted into 256 x 256 size arrays where each block represents the pixel value. The acquired images may have noise and other discolorations which aren't ideal for image processing. All of those ambiguities need to be handled. This is carried out using the process of image segmentation, where the images are divided into smaller segments to map out the areas of interest and to avoid the areas which are less important, and which may cause disruptions to the accuracy of the system.

3.7 Feature Extraction

After the images are processed into proper format and divided into segments, the next very important step is feature extraction. This step in Convolutional Neural Network is done by using activation function followed by max- pooling layers.

3.2.3.1 Activation Function-

The main purpose of using an activation function in a CNN is to decide which combination of weights and input will fire the next neuron. The activation function used in our CNN model is the ReLU activation function or Rectified Linear Unit activation function. This is very simple mathematical function, which outputs the input as long as the input is greater than zero, otherwise outputs zero. It can represented as y = max(0, x) where x is the input and y is the output.

3.8 Classification

After the layers of the Convolutional Neural Network are decided, we compile the model. The dataset is divided into training and test datasets, we have used 20% of the dataset for validation. We have an epoch value of 25, where epoch value is the number of passes that the model makes over the dataset. Real-time image processing functions are used to capture the different features of the image. Once, the model is trained, it is tested on the validation dataset

IV. Result

The following graphs may be seen after compiling our model and training it on train data with an epoch value of 25, then plotting the training and validation accuracy and the training and validation loss. The accuracy and loss of the training and validation datasets tend to converge at one point at the end of the 25 epochs, according to these graphs.

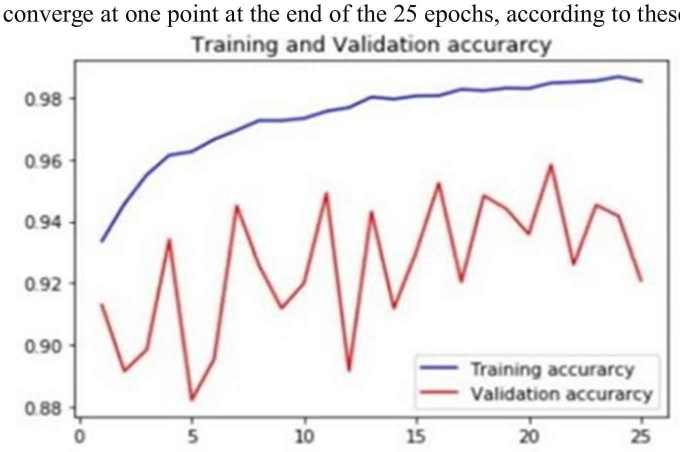
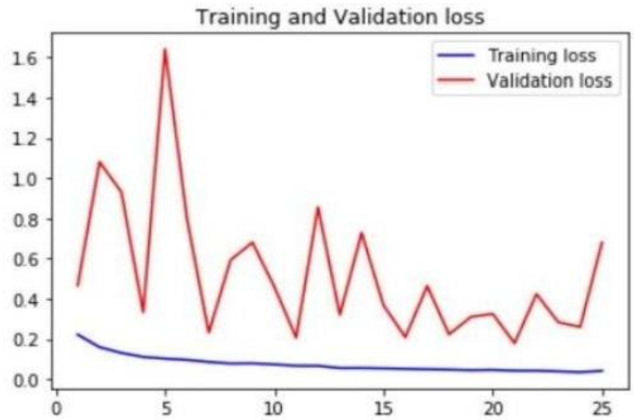


Figure 4: Plot of Training and Validation Accuracy

On connecting the backend model to the frontend and deploying it on the server, the users can simply upload the pictures of the affected plant leaves and get the consultation for it at the click of a button



V. Conclusion

Based on the findings obtained after applying our Convolutional Neural Network model, it is safe to conclude that our model is capable of accurately identifying and classifying the numerous plant illnesses found in the dataset. Furthermore, we may improve the accuracy of our model by raising the epoch value, but at the expense of processing time. It would be more useful to enhance the size of our dataset by collecting photos of additional plants and diseases to make the plant disease detection procedure adapt to more plants and diseases.

Commercialization of our product can include deploying of a mobile app where users can click pictures of the plant diseases in real time and upload it, to get a consultation instantly. Furthermore, the state of the plants can be tracked around the clock using hyper spectral imaging.

VI. Acknowledgement

The authors would like to thank Asst Prof. Mrs. Kavyashree G.M for her continuous motivation and guidance for the development of this paper. Also, we gratefully acknowledge all the journal papers that helped us in the development of this system. Also, we gratefully acknowledge all the journal papers that helped us in the development of this system.

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