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Plant Disease Classification using Deep Learning& Image Processing

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Abstract: *Identification of the plant diseases is the key to prevent the losses in the yield and quantity of the agricultural product. The studies of the plant diseases mean the studies of visually observable patterns seen on the plant. Health monitoring and disease detection on plant is very critical for sustainable agriculture. It is very difficult to monitor the plant diseases manually. It requires tremendous amount of work, expertise in the plant diseases, and also require the excessive processing time. Hence, image processing is used for the detection of plant diseases by capturing the images of the leaves and comparing it with the data sets. The data set consist of different plant in the image format. Apart from detection users are directed to an e-commerce website where different pesticides with its rate and usage directions are displayed. This website can be efficiently used for comparing the MRP's of different pesticides and purchase the required one for the detected disease. This paper aims to support and help the green house farmers in an efficient way.*

Keywords: Image Processing, Plant Disease Detection, Neural Network, Deep Learning, Segmentation.

I. INTRODUCTION

India is a cultivated country and about 70% of the Population depends on agriculture. Farmers have large range of diversity for selecting various suitable crops and finding the suitable pesticides for plant. Hence, damage to the crops would lead to huge loss in productivity and would ultimately affect the economy. Leaves being the most sensitive part of plants show disease symptoms at the earliest. The crops need to be monitored against diseases from the very first stage of their life-cycle to the time they are ready to be harvested. Initially, the method used to monitor the plants from diseases was the traditional naked eye observation that is a time-consuming technique which requires experts to manually monitor the crop fields. In the recent years, a number of techniques have been applied to develop automatic and semi-automatic plant disease detection systems and automatic detection of the diseases by just seeing the symptoms on the plant leaves makes it easier as well as cheaper. These systems have so far resulted to be fast, inexpensive and more accurate than the traditional method of manual observation by farmers In most of the cases disease symptoms are seen on the leaves, stem and fruit. The plant leaf for the detection of disease is considered which shows the disease symptoms. There are many cases where farmers do not have a fully compact knowledge about the crops and the disease that can get affected to the crops. This paper can be effectively used by farmers thereby increasing the yield rather than visiting the expert and getting their advice.

The main objective is not only to detect the disease using image processing technologies. It also directs the user directly to an e-commerce website where the user can purchase the medicine for the detected disease by comparing the rates and use appropriately according to the directions given. Greenhouse also called a glasshouse, or, if with sufficient heating, a hoth house, is a structure with walls and roof made chiefly of transparent material, such as glass, in which plants requiring regulated climatic conditions are grown. As greenhouse farming is gaining more importance now a day's, this paper helps the greenhouse farmers in an effective way. Various techniques can be used to review the plant disease detection and discuss in terms of various parameters. The paper is organized into the following sections. First section gives a brief introduction to the importance of plant disease detection. Second section discusses the existing work carried out recently in this area and also reviews the techniques used. Section three includes methodologies used in our paper. Lastly, fourth section concludes this paper along with future directions

II. LITERATURE SURVEY

In the paper ―Deep learning for Image-Based Plant detection" [1] the authors Prasanna Mohanty et al., has proposed an approach to detect disease in plants by training a convolutional neural network. The CNN model is trained to identify healthy and diseased plants of 14 species. The model achieved an accuracy of99.35% on test set data. When using the model on images procured from trusted online sources, the model achieves an accuracy of 31.4%, while this is better than a simple model of random selection, a more diverse set of training data can aid to increase the accuracy. Also some other variations of model or neural network training may yield higher accuracy, thus paving path for making plant disease detection easily available to everyone.

Malvika Ranjan et al. in the paper ―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 properlychoosing feature values to distinguish diseased plants and healthy samples. The ANN model achieves an accuracy of 80%.

According to paper ―Detection of unhealthy region of plant leaves and classification of plant leaf diseases using texture features" [3] by S. Arivazhagan, disease identification process includes four main steps as follows: first, a color transformation structure is taken for the input RGB image, and then by means of a specific threshold value, the green pixels are detected and uninvolved, which is followed by segmentation process, and for obtaining beneficial segments the texture statistics are computed. At last, classifier is used for the features that are extracted to classify the disease..

Kulkarni et al. in the paper ―Applying image processing technique to detect plant diseases" [4],a methodology for early and accurately plant diseases detection, using artificial neural network (ANN) and diverse image processing techniques. As the proposed approach is based on ANN classifier for classification and Gabor filter for feature extraction, it gives better results with a recognition rate of up to 91%.

In paper ―Plant disease detection using CNN and GAN" [5], by Emaneul Cortes, an approach to detect plant disease using Generative Adversarial networks has been proposed. Background segmentation is used for ensuring proper feature extraction and output mapping. It is seen that using Gans may hold promise to classify diseases in plants, however segmenting based on background did not improve accuracy.

In the paper ―Convolutional Neural Network based Inception v3 Model for Animal Classification‖ [6],Jyotsna Bankar et al. have proposed use of inception v3 model in classifying animals in different species. Inception v3 can be used to classify objects as well as to categorize them, this capability of inception v3 makes it instrumental in various image classifiers.

III. METHOD OF DISEASE DETECTION

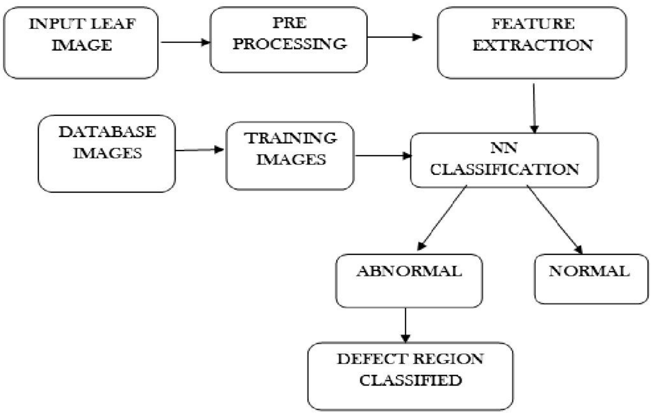


Fig. 1. Block Diagram

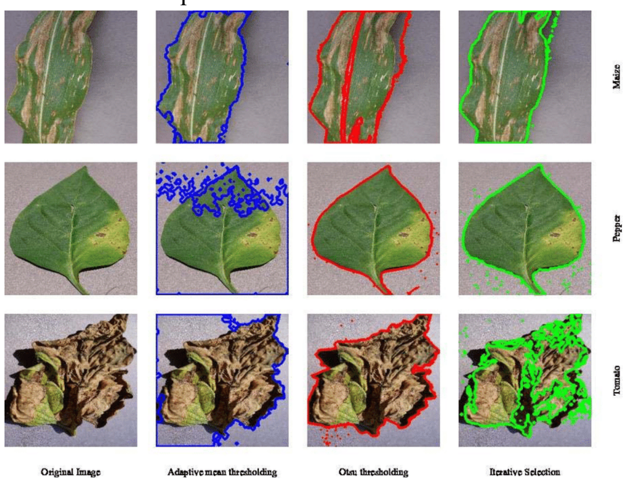
The process of plant disease detection system basically involves four phases as shown in Fig 3.1. The first phase involves acquisition of images either through digital camera and mobile phone or from web. The second phase segments the image into various numbers of clusters for which different techniques can be applied. Next phase contains feature extraction methods and the last phase is about the classification of diseases.

3.1 Image Acquisition

In this phase, images of plant leaves are gathered using digital media like camera, mobile phones etc. with desired resolution and size. The images can also be taken from web. The formation of database of images is completely dependent on the application system developer. The image database is responsible for better efficiency of the classifier in the last phase of the detection system. Image Segmentation This phase aims at simplifying the representation of an image such that it becomes more meaningful and easier to Analyze. As the premise of feature extraction, this phase is also the fundamental approach of image processing. There are various methods using which images can be segmented such as k-means clustering, Otsu's algorithm and theholding etc. The k-means clustering classifies objects or pixels based on a set of features into K number of classes. The classification is done by minimizing the sum of squares of distances between the objects and their corresponding clusters.

3.2 Image Segmentation

Image segmentation is the method of dividing an image into different sub images. Here we use K-mean segmentation technique which uses hue estimation method for dividing and clustering the image. Since the green colour of the leaves is normal, we do not consider them. We select the cluster image showing the infected area for feature extraction. Figure 4, below shows the segmented images of the leaves. K-means clustering algorithm, the data vectors are grouped into clusters based on the closeness of the pixels by the Euclidian distance measurement. Centroids of the clusters are initialized randomly and their dimensions are equal to data vectors.



3.3 Feature Extraction

Hence, in this step the features from this area of interest need to be extracted. These features are needed to determine the meaning of a sample image. I Features can be based on color, shape, and texture. Recently, most of the researchers are intending to use texture features for detection of plant diseases. There are various methods of feature extraction that can be employed for developing the system such as gray-level co-occurrence matrix (GLCM), color co-occurrence method, spatial grey-level dependence matrix, and histogram based feature extraction. The GLCM method is a statistical method for texture classification.

3.4 Classification

The classification phase implies to determine if the input image is healthy or diseased. If the image is found to be diseased, some existing works have further classified it into a number of diseases. For classification, a software routine is required to be written in MATLAB, also referred to as classifier. A number of classifiers have been used in the past few years by researchers such as k-nearest neighbor (KNN), support vector machines (SVM), artificial neural network (ANN), back propagation neural network (BPNN), Naïve Bayes and Decision tree classifiers. The most commonly used classifier is found to be SVM. Every classifier has its advantages and disadvantages; SVM is simple to use and robust technique.

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IV. OVERVIEW OF PLANT DISEASE

Plant diseases are generally caused by infectious agents such as fungi, bacteria, and viruses. Signs of plant disease are observable evidence of infection and symptoms are the visible effects of these kinds of disease. Fungal infections cause signs like visible spores, mildew, or mold and the basic symptoms are like leaf spot and yellowing. Fungal diseases are plant infections caused by fungi. Fungi can be single or multicellular, but either way infect plants by stealing nutrients and breaking down tissue. Fungal diseases are the most common infection in plants. There are some characteristic symptoms, or observable effects of the disease, in plants.

Fungi infections can be recognized by symptoms like spots on plant leaves, yellowing of leaves, and birds-eye spots on berries. With some fungal diseases, the organism itself can actually be viewed on the leaves appear as a growth and as a mold,

Fig. 2. Leaf affected by fungal infection

These may malformations on stems or the underside of leaves. These direct observations of the Disease-causing organism are called signs of infection Bacteria are single-celled, prokaryotic organisms. Bacteria are everywhere and many can be beneficial, but some can cause disease both in humans and plants. The signs of bacteria are often harder to detect than fungi, since bacteria are microscopic. Upon cutting an infected stem, a milky white substance may appear, called bacterial ooze. This is one sign of a bacterial infection. Other signs include water-soaked lesions, which are wet spots on leaves that ooze bacteria. Eventually, as the disease progresses, the lesions enlarge and form reddish-brown spots on the leaves. A common symptom of bacterial infection is leaf spots or fruit spots. Unlike fungal spots, these are often contained by veins on the leaf.

Fig. 2.Leaf affected by bacteria

Viruses are infectious particles that are too small to be detected by a light microscope. They invade host cells and hijack host machinery to force the host to make millions of copies of the virus.

Viral diseases don't show any signs in plants since viruses themselves cannot be seen even with a light microscope. However, there are symptoms that the trained eye can observe. A mosaic leaf pattern, yellowed, or crinkled leaves are all characteristic of viral infection. This classic pattern of discoloration is where many plant viruses get their name, such as the tobacco mosaic virus. Also, decreased plant growth is also commonly seen in viral infections.

Fig. 3.Leaf affected by virus

So, these are our observation on how to classify the various plant disease and how to be cautious about that.

V. PROPOSED SYSTEM

Proposed system has an end-to-end Android application with TFLite. Proposed system opted to develop an Android application that detects plant diseases. It has the algorithms

and models to recognize species and diseases in the crop leaves by using Convolutional Neural Network. Proposed system use Colab to edit source code.

A dataset of 54,305 images of diseased and healthy plant leaves collected under controlled conditions Plant Village dataset. The images cover 14 species of crops, including: apple, blueberry, cherry, grape, orange, peach, pepper, potato, raspberry, soy, squash, strawberry and tomato. It contains images of 17 basic diseases, 4 bacterialdiseases, 2 diseases caused by mold (oomycete), 2 viral diseases and 1 disease caused by a mite. 12 crop species also have healthy leaf images that are not visibly affected by disease. Our dataset contains solutions for several plant textures such asPepper bell bacterial spot

1. Pepper bell healthy
2. Potato early blight
3. Potato late blight
4. Squash powdery mildew
5. Strawberry leaf scorch
6. Tomato bacterial spot
7. Tomato early blight
8. Tomato late blight
9. Tomato leaf mold
10. Tomato sectorial leaf spot
11. Tomato spider mites two spotted spider mite
12. Tomato target spot
13. Tomato yellow leaf curl virus
14. Tomato mosaic virus

Data generators that will read pictures in our source folders, convert them to `float32` tensors, and feed them(with their labels) to our network is set up. As data that goes into neural networks should usually be normalized in some way to make it more amenable to processing by the network. In our case, we will pre-processour images by normalizing the pixel values to be in the `[0,1]` range (originally all values are in the `[0, 255]` range).We will need to make sure the input data is resized to224x224 pixels or 299x299 pixels as required by the networks. You have the choice to implement image augmentation or not. Apart from just detecting the plant disease using the above methods our system directs the user to an e-commerce website. This website displays all the pesticides that are available for the detected disease with its MR Prate. Along with this the directions to use it is also available in the website. Thus by comparing the rate and features of the pesticides the user can purchase it.

VI. CONCLUSION

This paper proposes a CNN based method for plant disease classification using the leaves of diseased plants. Building such a neural network with high efficiency is a complex task. Transfer learning can be employed to achieve greater efficiency. Inception v3 is one of the models available that inherently have the capability to classify images and further can be trained to identify different classes. Thus, use of Inception v3 can play key role in obtaining fast and effective plant disease identifiers. Also by dataset classification using contour method, the training set can be chosen to ensure proper training of model for all features. This provides better feature extraction than randomly classifying the dataset. Optimal results were obtained by employing the methods specified in the paper. Thus, with implementation and use of these methods for plant disease classification losses in agriculture can be reduced

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