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Mobile Application for Plant Disease Recognition Using Transfer Learning

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Abstract - *In this paper we have proposed the idea of mobile application for recognition of plant disease using transfer learning technique. Here we have used VGG16 CNN model trained on ImageNet dataset as a base model. Plant disease recognition is an important phase while cultivating plants. Manual identification of disease may take time resulting heavy losses. Using this application user can easily predict and get diagnosis on predicted disease just by clicking or uploading leaf image of infected plant from mobile device. In this application we have provided 15 different plants. For every plant category we have trained individual transfer learning model so it can accurately identify the disease.*

Key Words: **Transfer Learning**, **VGG16**, **CNN**, **Plant Disease**, **Mobile Application, Agriculture**

1.INTRODUCTION

The plants are the basic and important element of food chain. Plants produces food, All the species are directly or indirectly dependant on them for their survival. food is the major factor in living life. According to FAO (Food and Agriculture Organisation of United Nations) plants account for over 80% of the human diet. As such, they are essential for food security, or the ongoing access to sufficient, affordable, safe, and nutritious food for us all to live active and healthy lives. The diseases on the plants are evolving and increasing rapidly which is resulting in poor quality of food. These diseases cause huge loss to the farmer and other communities as well. Nowadays, Identifying and controlling the spreading of the disease is an important challenge.

Here we have tried to recognise the disease on infected plant leaf using Transfer learning, which is a machine learning technique. In this technique the pretrained CNN models and their weights are used for solving problem on custom use cases. Using this technique, it is possible to reduce the required dataset and the resources required for the model training.

As an interface for the proposed system, we have created a mobile application which is developed using Flutter framework. Flutter framework is Open-source UI software development kit created by google. It is used to develop cross platform applications for Android, iOS, Linux, Mac, Windows, Google Fuchsia, and the web from a single codebase.

2. RELATED WORK

To identify the plant disease on the leaf there are various methods, techniques has been proposed.

In this work [1], A CNN architecture Plant Disease Detection Neural Network (PDDNN) is proposed for effective classification of plant diseases. In this architecture single model is developed for 10 different plant disease classes from plant village dataset. It achieved the overall accuracy of 86%.

In [2], A Mobile application based on deep transfer learning is proposed. In this proposed system single model for classification of 10 plants and 27 classes is used from AI Challenger 2018 dataset. The proposed CDCNNv2 model which is based on ResNet50 pretrained on ImageNet dataset gives accuracy of 92%.

In [3], A transfer learning model and simple deep learning model based on DenseNet121 for plant disease detection are proposed. The model is trained with respect to different input sizes of an images from plant village dataset.

In [4], A deep CNN (Convolutional Neural Network) model is proposed capable of classifying the 15 classes of plant disease including healthy and background images. This architecture gives the overall accuracy of 96.3%.

In [5], The performance of Google Net and Alex Net was tested on plant village dataset on different classification configurations. The analysis is performed on different type of images like grayscale, colored, leaf segmented. And the configuration varies on model training type like training from scratch and using transfer learning. It is found that the Google Net performed well as compared to Alex Net and based on method of training transfer learning always gives better results.

3. METHODOLOGY

We are proposing the methodology of transfer learning for detection of plant disease and created models for each plant category separately. Transfer learning is the Machine learning technique used in use cases when the size of dataset and computing resources are limited.

Steps for developing transfer learning model:

1. Selection of pretrained model.
2. Design the classifier i.e., the custom use case classifier in classification problem.
3. Freeze the layers of base model while training.

4. Combine the base model and classifier.
5. Train the combined model using custom use case dataset.

VGG16 (Visual Geometry Group) CNN model proposed by K. Simonyan and A. Zisserman from the University of Oxford it is also known as Oxford Net. It is trained on ImageNet dataset and achieves 92.7% top-5 accuracy. ImageNet dataset is dataset containing over 15 million labelled high resolution image datasets belonging to 22000 categories.

The architecture of VGG16 is given in fig.1. [6]

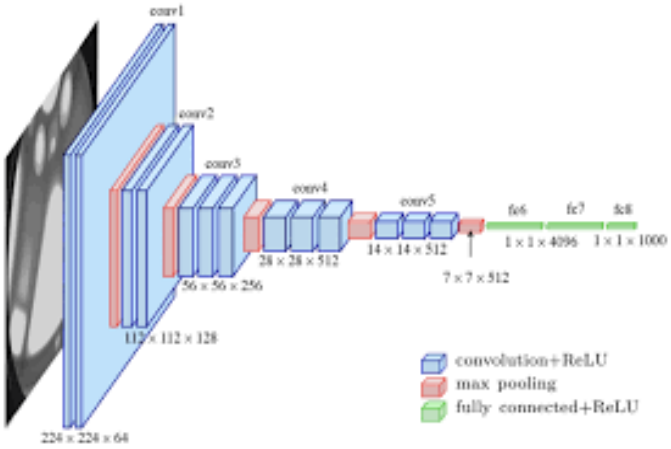

Fig -1: VGG16 Architecture

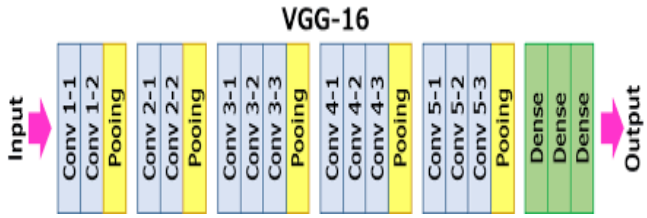

Fig -2: Layers in VGG16

Following are the custom layers:

layer 1 - Output from VGG16 as Input to custom layers
layer 2 - Global Average Pooling layer2D (2,2)
layer 3 - Fully Connected (1024, ReLU)
layer 4 - Fully Connected (1024, ReLU)
layer 5 - Fully Connected (512, ReLU)
layer 6 - Fully Connected (No_Of_Classes, SoftMax) (Output layer)

Next, we are going to freeze the base model layers according to accuracy. Only weights are transferring from base model to the classifier (Custom layers).

4. DATASET DESCRIPTION

We have used the plant village dataset as well as gathered dataset from internet. As we are building the models for each category of plant, so the organized dataset is as follows:

No.	Plant Species	No of training Images	No of validation Images
1.	Apple	2000	200
2.	Tomato	6861	1272
3.	Grass family (Corn, Jawar)	3599	400
4.	Potato	2700	300
5.	Grape	2000	200
6.	Rice	8000	1600
7.	Citrus Family (Lemon, Orange, Sweet lemon)	1975	200
8.	Beans Family (Black-eyed, Mung, Cluster)	1800	180
9.	Coffee	2400	400
10.	Aloe vera	2700	310

Table -1: Dataset specifications

4. MOBILE APPLICATION

We are providing a mobile application as an interface to the system which can be used on Android or iOS mobile device. This is a simple to use application where user has a feasibility of choosing plant type from 15 different categories for now. For chosen plant category user has to upload or capture the plant leaf image.

After above process the image and plant type will be sent to the server using base64 encoding as a string, then the image is regenerated using base64 decoding so that the respective trained model can recognize the disease or class of uploaded image. After recognizing the disease or class of that image it will send back the class name. At the Application end we have provided the facility to give Symptoms and diagnosis of the predicted disease which will help user to cure the disease. User interface for the application given below,

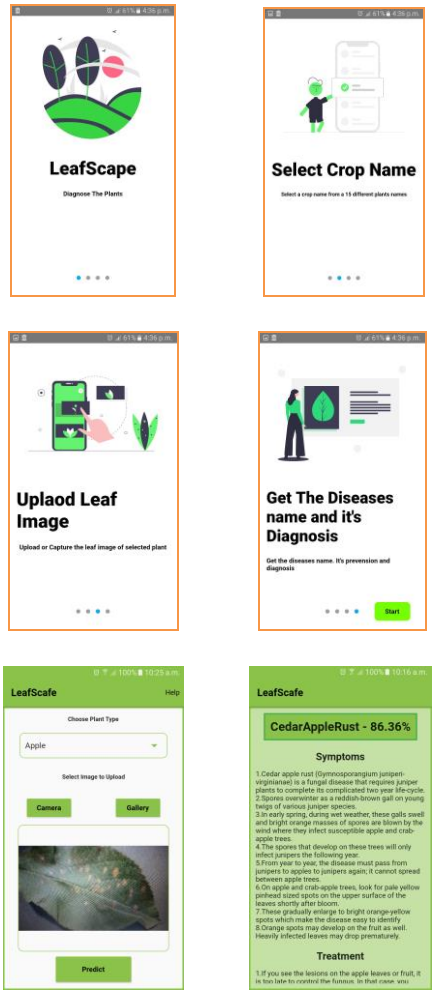

Fig -3: User Interface

5. MATHMATICAL MODEL

Let S be the Whole system which consists of:

S = {IP, Proc, OP}

Where,
IP = is the input to the system.
Proc = is the procedure applied on given input.
OP = is the Output generated by system after processing input.

A) Input:

IP = x, I.

Where,
x = Name of the plant/type of plant.
I = Image of leaf.

B) Process:

Proc includes,

1. Upload Input to the Server.
2. Process Image file according to the type of plant.
3. Make prediction of disease name.

C) Output:

OP = y, D.

Where,
y = predicted disease name.
D = Accuracy Score

6. CONCLUSION

In this paper, we have successfully proposed the Mobile application for plant disease detection. Specifically, we have proposed a series of transfer learning models using VGG16 which can recognize and give diagnosis accordingly. The proposed system successfully predicts disease on 15 different types of plants using separate model for each species.

7. FUTURE WORK

As we are using individual transfer learning model to detect diseases for each plant, it will become easy to implement new model for newly discovered datasets.

8. ACKNOWLEDGEMENT

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