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Ayur-Vriksha A Deep Learning Approach for Classification of Medicinal Plants

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Abstract - *Phytotherapy plays a vital role in maintaining the health and well-being of human beings. Identification and classification of medicinal plants are essential to better treatment. However, a lack of expertise in this field severely limits the identification and classification of medicinal plants. This paper proposes Ayur-Vriksha, a Deep Learning Approach, which is based on Convolutional Neural Network (CNN) model and internally it uses Inception V3 and Agile methodology, and for classification of leaf, it uses features like shape, size, color, texture, etc. Ayur-Vriksha helps us to preserve the traditional medicinal knowledge carried by our ancestors and provides an easy way to identify and classify medicinal plants. Our model achieved a classification accuracy of 97% based on our trained dataset, and the proposed dataset contains more than 50 leaf samples of medicinal plants. Finally, the classification is done with Softmax. Ayur-Vriksha allows us to keep the medicinal knowledge passed on from generation to generation.*

Key Words: **Classification of Medicinal plant, Collection of Images, Training dataset, Leaf features, Transfer Learning InceptionV3, Agile methodology, Convolutional Neural Network (CNN).**

1. INTRODUCTION

Health is a vital issue for the human race. In recent times, people's concern regarding health issues has increased exponentially. For developing countries, health care is a fundamental need. Due to the scarcity of doctors and physicians, people of the developing countries have less access to health care services. Thus, health care is a very challenging in these countries. By providing air and water on Earth, plants greatly facilitate the lives and biodiversity of living beings. Medicinal plants, a class of plants that plays a vital role in preventing and treating many diseases, are one of the most important classes of plants. Medicinal plants, one of the important classes of plants, serve as medicines for many diseases on earth by providing air and fresh water. Plants facilitate life by providing air, water, and food. By using pills and tablets (Modern Medicine) the disease will cure very fast but not in depth. India has valuable medicine called 'Ayurveda'. Ayurveda not only talks about physical health, but also emotional and spiritual health. The origin of Ayurveda dates back to the Vedic era. Most material relating to the health and diseases are available in Atharva Veda. Historians claim that Ayurveda is a part of Atharva Veda. However, Rig-Veda which is the earliest Veda also mentions about diseases and medicinal plants. This is totally herbal Medicine has no side effect and nearly 10,000 plants used for medicinal purposes. Although herbal medicine does not have any side effects, incorrectly identified medicinal plants may prove fatal to patients. Regardless, identifying a plant's medicinal value is one of the most difficult tasks. At this point, thus, it is necessary to set up an automated system capable of correctly classifying medicinal plants.

It may be possible to bridge the gap between a lack of experts and potential requirements in identifying and classifying medicinal plants by using computer vision and image processing methods. Plants are classified by researchers using their shapes, colors, and textures as morphological and spatial features. However, colors are not a useful feature for differentiation because they change throughout the year, as well as differently colored stages within the same leaf. In taxonomy, leaves are classified according to their leaf characteristics. The field has seen a lot of research. It still remains a challenging and unsolved problem due to the high rate of similarity among class members in terms of shape, color, and texture.

2. REVIEW OF LITERATURE

To date many researchers have proposed several methods and the fundamental aim of every research is deriving a new solution or invention to solve this problem of identification and classification of medicinal plants. These methods are discussed below in this section.

Dileep M. R. and Pournami P.N. [1] proposed a Convolutional Neural Network (CNN) model for classification and the classification is performed using softmax and SVM classifiers. Inception V3 is utilized for the efficient feature extraction from the dataset. This model achieved a classification accuracy of 96.76% and it is tested with leaf samples from 40 medicinal plants.

Jing Wei Tan et al. [2] proposed a D-Leaf is a venation-based CNN model, which employs CNN for feature extraction and ANN for classification. Edge detection is used to extract venation details from resized leaf images. The classification accuracy of D-Leaf model is 94.88%.

D. Venkatarama et al [3]. Presented an efficient technique for leaf classification, it is Computer Vision Based model to find the feature for classification of given medicinal plant leaves and to retrieve its medicinal details. This model uses Probabilistic Neural Network classifier to identify leaf. It consists of steps like pre-processing, feature extraction, classification, retrieval of medicinal values etc. and the feature vector calculation and similarity matching are involving for classification.

R. Janani et al. [7] developed an Artificial Neural Network (ANN)-based model to classify the medicinal plant by their features like color, texture and shape of leaves. The model used 36 leaves for training, 7 leaves for validation and 20 leaves for testing, 63 leaves in total. Out of 20 different features of leaves, 8 minimal prominent features were identified to classify the leaves. Compactness, eccentricity, skewness, kurtosis, energy, correlation, sum-variance and entropy are those minimal 8 features. Accuracy of this model is 94.4%.

Plant species classification has been studied extensively using various technologies. Deep learning offers good results and high accuracy over classical classification methods. Classification of compound leaves still needs to be studied. There is still a need to develop an efficient method of classifying all forms of medicinal leaves.

3. MATERIALS AND METHODS

3.1 Deep Learning

Deep learning is a subset of machine learning in which a computational model learns to execute classification tasks directly from images. Ayur-Vriksha performs classification on huge volume of image dataset, so for that deep learning approach is the best choice for classification. Deep learning has higher accuracy, ability to handle high volume of image dataset, inbuilt ability to use GPUs for parallel computing and availability of inbuilt pre-trained Convolutional Neural Network.

It has been possible to identify and classify plants using classical image processing and classification methods for a number of decades, using shape, texture, and color features based on the images. There are several features of these statistics including aspect ratio, eccentricity, kurtosis, skewness, energy, correlation, sumvariance, entropy, and compactness. This classical method has the major disadvantage of requiring excessive computation time for handcrafted feature extraction. Currently, machine learning techniques are replacing all of the classical methods.

3.2 Inception V3

Inception V3 is superior version of Inception V2 which was introduced in 2014. Inception V3 is a pre-trained convolutional network model which is trained with images from ImageNet dataset and it can classify 1000 different species. Inception V3 allows for multi-GPU training by putting half of the model's neurons on one GPU and the other half on another GPU. Not only does this mean that a bigger model can be trained, but it also cuts down on the training time.

This layer performs a basic convolution operation on the input images by using a fixed number of kernels having different dimensions in each layer. Extracting edge and color features of the input image is depends on starting layers and these layers also generate the feature maps of input image given to it. Feature maps are based on the size and number of filters applied to each convolutional layer. An output from the last convolutional layer is used as an input to the first fully connected layer.

The output of the fully connected layer is passed to the softmax layer for classification. Softmax calculates the probability of each species. There are 4096 neurons in the first two convolutional layers, and 1000 neurons in the last fully connected layer. SoftMax layer and pooling layer, these two layers play a key role in between every two convolutional layers. The pooling layers are used to perform max pooling. These two layers feature maps to keep all feature values positive and to reduce the size of the feature set respectively.

3.3 Agile Methodology

Agile is one of the more widely known project management methodologies because it is designed for incremental, iterative projects. Selforganizing and cross-functional teams and their customers collaborate to develop a solution that meets the customer's needs. Software development is the main application of this method. It was created in response to the shortcomings of the Waterfall methodology, whose processes failed to meet the requirements of an industry that is highly competitive and constantly advancing. We are using Agile Methodology for developing our software.

3.4 Ayur-Vriksha Dataset

Ayur-Vriksha is a proposed dataset which contains almost 10,000 categories of Medicinal plants but don't have dataset and higher GPU to identify all categories and train that model, so we took around 50 plants images for each plant we took 300 images and this is custom dataset.

Fig. 1. Sample set of pre-processed training images

The dataset is collected from natural scene by mobile device. Each category contains 300 different photos acquired by smartphone in natural environment and these medical plants are commonly found across Maharashtra. Apparently, 300 leaves of each class are selected for scanning after removing leaves with severe deformities and selecting leaves with a substantial difference in shape, color and size. In order to create 300 different leaf images per species, both top and bottom surfaces and edges of these selected 50 leaves are scanned. Using image editor, only leaf areas are selected and cropped, and then each image is saved as a jpg image format. The naming convention is used to name each image so it helps the model to provide more accurate classification result.

3.5 Ayur-Vriksha Proposed CNN Architecture

The architecture of our proposed system is given in Fig.3. Ayur-Vriksha *Convolutional Neural Network i.e.,* CNN architecture is designed and developed based on the Inception V3 architecture. The Inception V3 has eight layers. The model consists of five layers with a combination of max pooling followed by 3 fully connected layers and they use SoftMax activation in each of these layers except the output layer.

The input layer is the first layer. The input layer specifies the dimension of the input images. Input layer is followed by the first convolution layer with 96 filters of size 11X11 with stride size of 4. The activation function used in this layer is SoftMax. The output feature map is 55X55X96.To calculate the output size of a convolution layer we use formula,

output= ((Input-filter size)/ stride) +1

Also, the number of filters becomes the channel in the output feature map. This layer is then followed by a SoftMax layer which thresholds the output. Next, we have the first Maxpooling layer, of size 3X3 and stride size 2. Then we get the resulting feature map with the size 27X27X96. After this, apply the second convolution operation. This time the filter size is reduced to 5X5 and we have 256 such filters. The stride is 1 and padding 2. The activation function used is again SoftMax. Now the output size we get is 27X27X256. Again, we applied a max-pooling layer of size 3X3 with stride 2. The resulting feature map is of shape 13X13X256. The next two layers are two back-to-back convolution layers. Now we apply the third convolution operation with 384 filters of size 3X3 stride 1 and also padding 1. Again, the activation function used is SoftMax.

The output feature map is of shape 13X13X384.Then we have the fourth convolution operation with 384 filters of size 3X3. The stride along with the padding is 1. On top of that activation function used is SoftMax. Now the output size remains unchanged i.e., 13X13X384. After this, we have the final convolution layer of size 3X3 with 256 such filters. The stride and padding are set to one also the activation function is SoftMax. The resulting feature map is of shape 13X13X256. Third fully connected layer has 40 neurons, which is equal to the number of classes of the medicinal plant to be classified. Finally, the output of the third fully connected layer is given to the softmax classification layer which calculates classification probabilities for each species.

The proposed CNN model performs the following steps.

1) Image Acquisition: The dataset is collected from natural scene by mobile device. Each category contains 300 different photos acquired by smartphone in natural environment and these medical plants are commonly found across Maharashtra. In order to create 300 different leaf images per species, both top and bottom surfaces and edges of these selected 50 leaves are scanned.

The top and bottom face image sample of a medicinal plant is given in Fig.2.

Fig.2. Top and bottom faces of leaves

2) Image Pre-processing: It is the objective of the pre-processing step to convert the scanned images into an input format that is accepted by CNN, which is a dimension of

227x227x3. Images were used in RGB format and converted into the 227x227x3 format if they were not in the required format. Our dataset has images of varying dimensions, so we first padded the images to NxN dimensions by performing scaling. And finally, resized the padded images to 227x227x3 dimensions by performing scaling.

3) Feature Extraction: All the designed CNN models are trained and tested using Ayur-vriksha dataset and results are compared against Inception V3 results. We designed CNN models with different number of layers, number of filters and filter size with varying training options. A number of convolutional, max-pooling, and SoftMax layers, as well as the number of neurons placed in the first two fully connected layers, determine the performance of these models. The proposed Ayur-Vriksha CNN is designed based on the results of these analyses. The accuracy of the model highly depends on the number of images used for training the model. Once the training and validation processes are complete, the images from the test set are given to obtain the accuracy of the model.

The Ayur-Vriksha model then outputs the training and validation accuracy via the accuracy graph, and classification accuracy via the confusion matrix. As you can see Fig.3 the architecture of Convolution Neural Network our Inception V3 also uses same CNN with more layers. All basic operation like Max pooling, Dense Layer which will take place. Here as in diagram 5 Convolution Neural Networks are there but in original Inception V3 model it is pretrained Convolution Neural Network model which uses 48 layers deep.

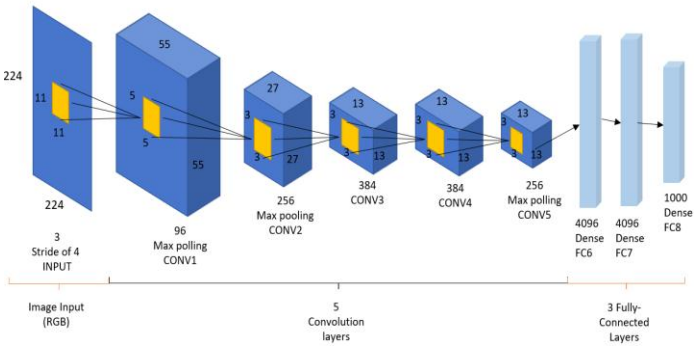

Fig.3. CNN Architecture

4. RESULT AND DISCUSSION

The training and testing of Ayur-Vriksha model are done using our own Ayur-Vriksha dataset. The model is tested and compared with Inception V3 and fine-tuned Inception V3 models.

We check with CNN model with 91% Accuracy. Then we apply Transfer Learning Techniques like AlexNet which gives 94% Accuracy and finally by using InceptionV3 we got 97% Accuracy. The comparison of accuracy bar graph shown below Fig.4

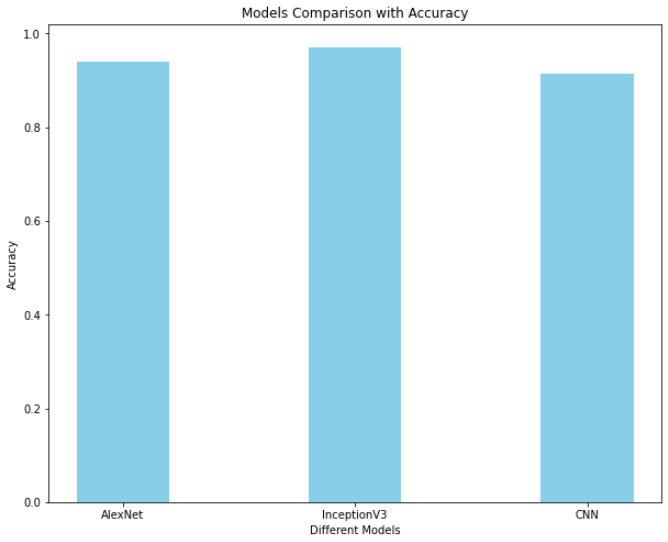

Fig.4. Comparison accuracy graph

For classifying leaf samples in the Ayur-Vriksha dataset, the proposed InceptionV3 architecture is evidently more effective than other models.

5. CONCLUSIONS

In this study, we develop a deep learning based medicinal plants leaves classification model which is based on its own trained and tested dataset. It is obtained the well-organized accuracy which is 97 %. In this proposed system use Sanskrit words for identifying the names of Medicinal plants. In addition, it may be of great help to pharmacists to recognize the correct medicinal plant in the field of medicinal plant leaves classification, as well as help in the process of making medicines.

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