Detection of Diseases in Arecanut Using Convolutional Neural Networks

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Abstract - Arecanut is a tropical crop, which is popularly known as betel nut. India ranks second in producing and consuming arecanut in the world. Throughout its life cycle, it is affected by a variety of diseases, from root to fruit. The current approach for detecting diseases is simply observation with the naked eye and farmers have to carefully analyze each and every crop periodically to detect the diseases. In this paper, we proposed a system that helps in detecting the diseases of arecanut, leaves, and its trunk using Convolutional Neural Networks and suggests remedies for it. A Convolutional Neural Network (CNN) is a Deep Learning algorithm that takes input as an image, assigns learnable weights and biases to various objects in the image, and then learns from the results to distinguish one from the other. To train and test the CNN model, we created our own dataset which consists of 620 images of arecanut both healthy and diseased. The train and test data are divided into a ratio of 80:20. For compilation of model categorical cross-entropy is used as loss function with adam as optimizer function and accuracy as metrics. A total of 50 Epochs are used to train the model to achieve high validation and test accuracy with minimum loss. The proposed approach was found to be effective and 88.46 percent accurate in identifying the arecanut disease.

Key Words: Arecanut, Machine learning, Convolution Neural Networks.

1.INTRODUCTION

Agriculture is India's main profession. India is the world's second-largest producer of agricultural products. In developing countries like India, the economy mainly depends on agriculture. Farmers in India grow a diverse range of crops. Crop development is influenced by a variety of factors such as climatic conditions, soil conditions, disease, and so on.

The current approach for detecting plant diseases is simply observation with the naked eye and farmers have to carefully analyze each and every crop periodically to detect diseases, which is an extremely challenging and time-consuming task and which requires more manpower, adequately equipped laboratories and costly instruments and its not possible for early detection of the diseases and avoid spreading of disease. Hence, there is a need for an automatic disease detection system.

India is the highest producer of arecanut with a production of around 3.3lakh tones and a total acreage under cultivation of 2.64lakh hectares, with Karnataka and Kerala accounting for nearly 72 per cent of the total production.

Commonly found diseases in areca tree are Mahali Disease (Koleroga), Bud Rot Disease, Stem Bleeding, Yellow Leaf spot, Yellow Disease which occurs due to continuous rainfall and climatic changes, these diseases must be controlled in the primary stage of infection otherwise it may cause difficult to control in the final stage which may lead to loss to the former.

To avoid this, we can use Machine Learning to detect disease and suggest remedies to it. Arecanut disease detection can be done by looking for a spot on the affected nut, leaves, and trunk. Machine Learning specifically Convolution Neural Networks is the method we're using to detect the diseases.

In this project we are going to identify Mahali disease (Kole roga), Stem Bleeding and yellow leaf spot diseases and suggest solutions for the detected disease.

Figure 1: Healthy and diseased images of areca nut, trunk and leaf

Mahali Disease: The disease is caused by *Phytophthora meadii*. The disease is widespread in occurrence in all arecanut growing tracts. The crop losses due to this disease vary from 10-90 percent depending on the weather conditions. The first visual symptoms appear as water-soaked lesions on the nut surface near the penanth end. In severe cases, fruit stalks and axis of the inflorescence are also affected. Usually, the diseased nuts will be lighter in weight as compared to other arecanut.

Stem Bleeding: Palms in the age group of 10-15 years are more prone to this disease. Symptoms appear on the basal portion of the stem as small discolored depressions. Later, these spots coalesce and cracks develop on the stem leading to disintegration of the fibrous tissues inside. With the progress of the disease, a brown exudate oozes out from these cracks. High water table predisposes the palm to this disease. The fungus *Thielaviopsis paradoxa* is associated with this disease.

Yellow Leaf spot: This disease is severe during the South-West monsoon season. Young palms of less than 10 years old are more susceptible. Infection is usually restricted to 3-4 leaves of lower whorl. The symptoms develop as small brown to dark brown or black round spots. They vary in size and are characterized by a yellow halo around and in advanced stages form blighted patches. In severe cases the infection causes drying, drooping and shedding of leaves. *Phyllosticta arecae and Colletotrichum gloeosporioides* are the pathogens involved in this disease

LITERATURE SURVEY:

Dhanuja K C (2020) Proposed a system for disease detection of arecanut using image processing technology and here the author followed texture-based grading of arecanut. For training and testing the model a total 144 arecanut samples used which includes 49 Good, 46 Poor and 49 Negative samples [1] and K-Nearest Neighbor (KNN) algorithm is used to detect the diseases in arecanut.

Ajit Danti, Suresh (2012) [2] Suggested a technique for segmentation and classification of raw arecanut. In this paper the novel method is proposed for classification of arecanut into two classes based on color which includes three steps: (i) Segmentation, (ii) Masking and (iii) Classification. And here in this paper classification is done based on red and green color components of the segmented region of arecanut.

Manpreet Sandhu, Pratik Hadawale [3] In this paper the author has developed an automated system for detecting disease using leaf image classification. The presence of spots or rotting areas in the plant leaf will be detected automatically by using machine learning algorithms. Here unmanned aerial vehicle (UAV) with a camera that automatically captures images of the leaves to automate the process of capturing images of the leaves.

Ashish Nage, V.R. Raut [4] This paper focuses on the approach based on image processing for detection of diseases of plants. Here is this paper the author developed an Android application that helps farmers in identifying plant disease by uploading a leaf image to the system which uses a convolution neural network algorithm to identify the disease in the leaf.

Anandhakrishnan MG, Joel Hanson, Annette Joy [5] In this, a dataset is created for training a neural network for image classification. The dataset was collected manually from the field. In this paper to get better feature extraction, image reprocessing was done, which includes noise removal, intensity normalization, removing reflections, and masking portions of the image. Then, using these processed images, a deep convolutional neural network model was trained to classify the images and TensorFlow library was used for numerical computations.

Patil Supriya, Mule Gitanjali, Labade Vidya [6] In this paper detect pomegranate diseases and also suggest the solution on diseases. The proposed system consists of image pre-processing, segmentation, extraction of features and classification. In image pre-processing, images are resized. In segmentation, color segmentation is carried out. Color, morphology and texture features (Gabor filter) are used for the feature extraction. Minimum distance classifier is used for classification purposes.

Swathy Ann Sam, Siya Elizabeth Varghese, Pooja Murali [7] In this paper the authors have used different algorithms (SVM, KNN, Decision tree, CNN) for detection of diseases in leaves. This project works on uploading a captured image of sample to the system and algorithm will detect weather the sample is affected by any diseases or not, if it is affected by any disease, it will print the detected disease, for this detection the authors have used CNN which gave an accurate percentage of 86%.

Objectives:

- To collect datasets that contain healthy and diseased images of arecanut and their leaves.
- Design and develop an algorithm for early detection of disease in arecanut that can avoid the spreading of diseases.
- Develop an algorithm that would suggest solutions for the detected diseases.

Proposed Model:

The project is divided into two parts:

- Dataset Collection.
- Training a neural network model for the prediction of plant diseases.

Datasets:

To detect various diseases of arecanut we created our dataset which consists of healthy and diseased images of arecanut and their leaves. The images were taken from a digital camera at a half-meter distance from the source. The diseased and healthy arecanut images were collected from Shigga, Shimoga district of Karnataka. These photographs were taken under the guidance of experienced arecanut researchers and farmers. The dataset contains a total of 620 images which includes leaves, nuts, and trunk of arecanut both healthy and diseased. There are 200 healthy and 420 diseased images of arecanut such as Yellow, yellow spot, Mahali/Koleroga, and Stem bleeding disease. The images are resized into 256*256 pixels using open-cv before training the model.

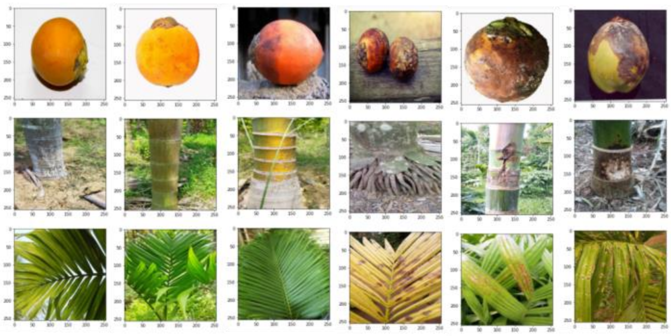


Figure 2: Sample Dataset

Training a neural network model for the prediction of plant diseases:

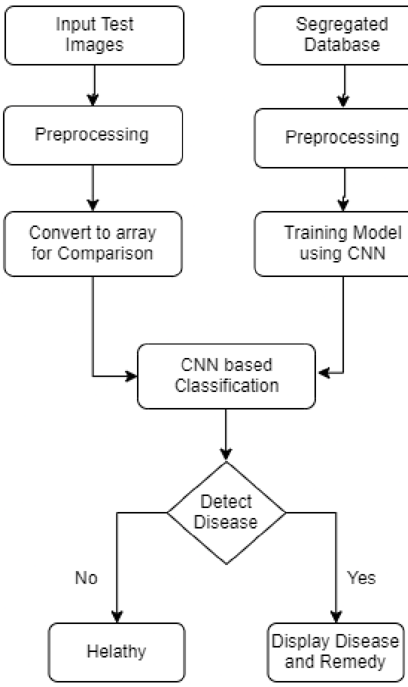


Figure 3: Working Design Model

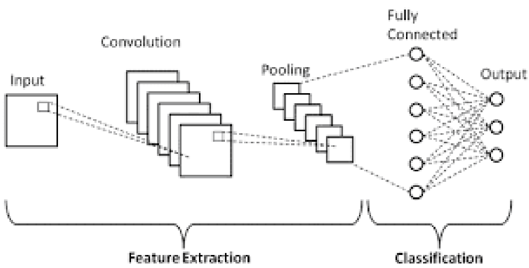


Figure 4: Simple CNN Model

A Convolutional Neural Network (ConvNet/CNN) shown in Figure 4. is a Deep Learning algorithm that can take in an image as input, assign importance (learnable weights and biases) to various aspects/objects in the image then learn from the results and be able to differentiate one from the other. As compared to other classification algorithms, the amount of pre-processing needed by a ConvNet is significantly less. Though filters in primitive methods are hand-engineered, ConvNets can learn these filters/characteristics with enough preparation. Figure 3. shows the working design of our model.

Preprocessing:

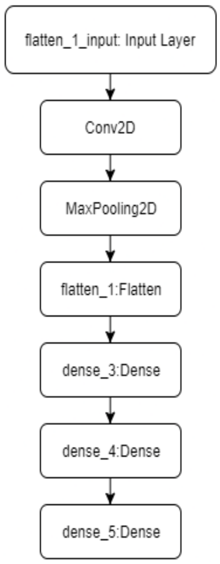
The database is preprocessed, which includes image reshaping, resizing, and array conversion. The test image is also subjected to similar processing. Images are resized to 256*256 resolutions and converted to an array before training the CNN model.

Convert images to Array:

Computers are unable to recognize or evaluate images in the same way that humans do. So, we have to figure out how to turn these images into numbers. Using Numpy we can convert these images to the array. The array contains RGB values of each pixel of an image ranging from 0 to 256.

Model Structure:

CNN has several layers, including Dropout, Convolution2D, Activation, Dense, MaxPooling2D and Flatten For training the model using CNN we used 1000 neurons in the first layer, 500 in the second layer, 250 in third and 5 in the last dense layer. The activation function used in the first 3 layers is relu and for the last layer softmax. A total of 248,655,647 parameters are calculated which includes the weights and biases. The last has a softmax activation function which gives the probability of detected disease. Below is the image of the layered structure of our model.



Training the model:

A total of 620 images which includes healthy and diseased images are used to train and test the Model. The dataset is limited so we used Augmentation technique which performs rotation, shifting, zooming, flipping the image to create new data for training.

The train and test data are divided into a ratio of 80:20. For compilation of model categorical cross entropy is used as loss function with adam as optimizer function and accuracy as metrics. A total of 50 Epochs are used to train the model to achieve high validation and test accuracy with minimum loss. The graph of accuracy v/s epochs and loss v/s epochs is shown in Figure 5. And Figure 6.

```
#Visualize model accuracy
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['Train', 'Val'], loc = 'upper left')
plt.show()
```

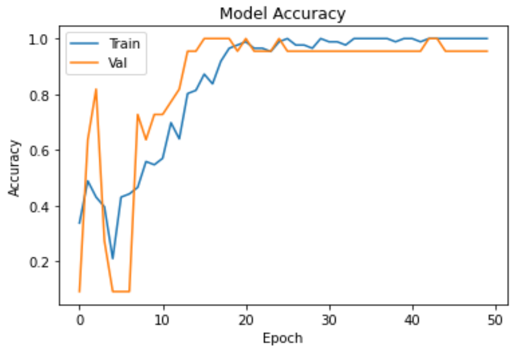


Figure 5: Accuracy v/s Epoch

```
#Visualize model loss
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('Model Loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['Train', 'Val'], loc = 'upper right')
plt.show()
```

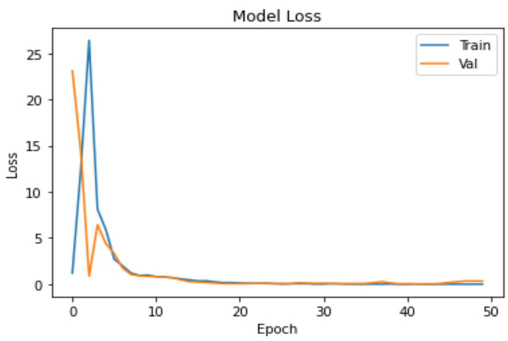


Figure 6: Loss v/s Epoch

Result and Discussion:

After training the model the test accuracy observed was 88.46 % which is shown in the Figure 7. The image of the leaf as shown in Figure 8. was given as input to the model trained using CNN. The trained model detects diseases in arecanut and prints the probability of the detected disease which is shown in Figure 8. Also, the remedy for the maximum probability disease is shown for the user reference.

```
print("[INFO] Calculating model accuracy")
scores = model.evaluate(x_test, y_test)
print(f"Test Accuracy: {scores[1]*100}")

[INFO] Calculating model accuracy
2/2 [==============================] - 0s 179ms/step - loss: 0.5850 - accuracy: 0.8846
Test Accuracy: 88.46153616905212
```

Figure 7: Model Accuracy

Figure 8: Input image for testing

```
result=model.predict(npp_image)
itemindex = np.where(result==np.max(result))
for i in range(len(result[0])):
    print(label_binarizer.classes_[i]+" "+str(round(result[0][i]*100,2))+ " %")
if itemindex[1][0]>2:
    print("\nRemedy for the "+ label_binarizer.classes_[itemindex[1][0]]+" :\n",Remedy[itemindex[1][0]])

Healthy_Leaf 1.18 %
Healthy_Nut 0.13 %
Healthy_Trunk 0.35 %
Mahali_Koleroga 0.23 %
Stem_bleeding 0.77 %
yellow_leaf spot_disease 97.35 %

Remedy for the yellow_leaf spot_disease :
 Disease can be controlled by spraying with one per cent Bordeaux mixture or Dithane M 45 @ 3 gram/Liter.
```

Figure 9: Prediction Result

CONCLUSIONS

This paper focuses on the early detection of diseases in Arecanut, leaves, and trunk using Convolutional Neural Networks. Experimentation is conducted using diseased and healthy arecanut image dataset of 620 images. The input image is first pre-processed, followed by feature extraction, training, and classification. The proposed System detects diseases of arecanut such as Mahali, Stem bleeding, and yellow leaf spot and provides remedies for the same. Depending on the quality of the input image and the stage of the disease, the experimental results show varying levels of disease detection accuracy. The overall accuracy of the system is estimated to be 88.46 percent. As a result, this system takes a step toward encouraging farmers to practice smart farming and allowing them to make better yield decisions by enabling them to take all the necessary preventive and corrective action on their arecanut crop.

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