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***Abstract*— One of the most common vegetables as Malabar cultivates is increasing day by day and the farmers are suffering from the Malabar disease known as scab disease on Malabar leaves. And the researcher is always trying to make a solution to protect Malabar from the disease. So that there are many papers already published and some of them also able to achieve a pretty accuracy and it's sometimes up to 85%. But This is not the perfect solution for the suffering farmers who are facing the loss of cultivation. We are trying to solve the issues and we also research on Malabar with 96.77%% accuracy which is height accuracy. We researched Malabar disease and made a project with Convolutional Neural Network(CNN) with respect to keras API and OpenCV and this is a classification model of Malabar disease recognition system. We took the input as Malabar leaves with the fixed input size is 200x200 which defines the RGB Malabar leaves image.**

Keywords*— *Malabar Diseases, Deep Learning, CNN, Keras, OpenCV, Classification.

I. INTRODUCTION

We are Bengali and we know our country's economic development mostly depends on agriculture. Our country's people mostly village people produce tea, jute, rice, vegetables and also fruits and they depend on agriculture. Amount of 47% of people in Bangladesh is choosing this lifestyle for a living as a farmer. Third-placed worldwide for vegetable creation in Bangladesh. According to the worldwide position, Bangladesh is not still now under digitalized. Improvement in our agrarian part can roll out an extraordinary By the cutting edge advances for a large number of accessible gave as highlights.

On the other hand, other countries like Sweden, Norway, Japan, England and also USA etc most countries used advanced technology for producing their cultivation but there is a piece of bad news for us as bangali we have no much-advanced technology and also not proper attention to solve this issue so that we can use advanced technology for developing our agricultural. Although Bangladesh stays better placed in worldwide as stay in the third position. But Bangladesh still now is not developed according to the agriculture-based country rather than another country. Though our adjacent Country India take initiative for about cultivating condition. For developing their agricultural field is just for using the advanced feature and also for advanced technology as Image Processing. They also make a surety in agriculture with Eggplant, Cucumber, Malabar Nightshade, Tomato for developing their country's economic purpose. The vegetable disease is not just a name of a disease, it destroys humans healthy and also destroys the economic system in a country. It also reduces the annual income per person in a country. Now, The leaf disease is known as Septoria Leaf is for tomato, Anthracnose, Cercospora Leat Spot, Damping-Off, Root Rot is for eggplant, Leaf Spot, Bacterial Wilt if for cucumber, Malabar Nightshade is for Malabar is the most common leaf disease of differents type so vegetable disease. Here These diseases not only destroy our

cultivating products but also affects our health and unfortunately it has fallen us in dangers to economical and also healthy. Therefore, the application must be minimized to use advanced technologies like Machine learning, Deep learning, Artificial Intelligence based so that we consume our time also economical effects. The designed application, we have used for classifying the vegetable disease based on leaf disease and it will be too fast for the using the Deep Learning method as Convolutional Neural Network (CNN). We throught, the early detection of the vegetables diseases must be facilitated so that it will be controlled for using the purpose of the proposed method for the easiest approaches. For the purpose of using this model it will be like fungicide as detecting the disease of the vegetable disease and the application provides the reality result for detecting wanted approach. It can be helpful for increasing productivity and profitability in the agricultural field as products vegetables. We are inspired to study various diseases and also, we want to make solutions for increasing GDP and want to reduce the loss of farmer's economies. So that we proposed a CNN means Convolutional Neural Network with better accuracy and able to prove ourselves by the accuracy and predictions.

II. Related Work

The (Mojumdar & N. R. Chakraborty, 2020) scab disease recognition model on Malabar leaves is able to achieve 82.15% accuracy and able to predict scab disease on Malabar. This is a computer vision techniques for detecting the scab on Malabar nightshade were used four classification algorithms and able to achieve an accuracy as SVMs is 82.15%, Bayes Net is 78.26%, Trees.J8 is 79.63% and Function Logistics is 76.20%. This paper is mainly a competitive based research paper. In (Muthukannan, Latha, Selvi, & Nisha, 2015) the disease plant leaf recognition technique's using NN(Neural Network) algorithms have been published for classifying the plant leaves disease based on deep learning and its Neural Network. Its also competitive research papers and there are used FFNN, LVQ, RBF algorithms and the accuracy is 92.1%, 95.1%, 71.2%. From the accuracy, it's clear to us that LVQ (Learning Vector Quantization) performs better than another twice and it's a too accurate algorithm. A (Ma, et al., 2018)method to recognize the cucumber disease based on leaf symptom image data for DCNN method is published for recognition of cucumber disease. They have used AlexNet and DCNN(Deep Convolutional Neural Network) and AlexNet performs better than DCNN and the accuracies are 94.0% and 92.6%. For the better performance of AlexNet, they have decided to use AlexNet to recognize the cucumber disease for the farmers used. This (Mangena, et al., 2020) paper used Image Processing and also used Machine Learning techniques to classify and recognize the pomegranate leaves disease. Their proposed framework is implemented by using MATLAB techniques with GUI (Graphical User Interface) and the proposed method performs with 98.07% accuracy for classifying the Pomegranate leaves disease as disease leaves and healthy leaves. In (Adedoja, Owolawi, & Mapayi, 2019) this paper, They have used NASNet for plant disease recognition using plant leaves images based on deep learning. They has achieved 93.82% accuracy after training the 9(Nine) epochs. They used two classes as disease leaf and healthy leaves and after recognition disease leaves it to ensure by the result. They categorize the leaves into two-part as healthy leaves and disease leaves. In (Mim, Sheikh, Shampa, Reza, & Islam, 2019) this paper, they have used Image processing techniques for detecting tomato leaves disease and they could achieve 92.61% accuracy for training and 96.55% accuracy for validation in the final section. Now They used 6,000 valid tomato leaves image data and it is divided into two-part as the training dataset and the testing dataset. Training data provides 80% and testing data are 20% used for performing their model using image processing techniques. This (Karmokar, Ullah, Siddiquee, & Alam, 2015) research paper belongs to Neural Network(NN) for recognizing the tea leaves disease and their proposed method is a tea leaf disease recognizer(TLDR). They are able to achieve 91% testing accuracy which is the overall accuracy of this Neural Network model. Again they make differents accuracy for using NCL and that's are "NCL with 05 NNs" is for 85% accuracy, "NCL with 10 NNs" is for 89% accuracy and "NCL with 05 NNs with feature extraction" performs better and that's accuracy is 91%. This (Zhong & Zhao, 2020) is apple leaves disease recognition using deep learning techniques and mainly Densenet-121 in Deep Convolutional Network which have three regression methods and also focus on multi-label which is defines the classification. For the ability of multi-label is classification, this method provides three accuracies and the accuracies are 93.51%, 93.31% and 93.71% with respect to the test dataset. This (B, Badam, Chirunjeevi, & Kumar, 2020) is mainly design and implementation based on image processing and classification of plant leaves into two categories as healthy leaves and unhealthy is also known as disease leaves. They have used image processing techniques with 90% accuracy or above. This (Rahman, Jabiullah, Sultana, Rashiduzzaman, & Parven, 2020) is a computer vision-based research paper for recognizing the plant leaves disease using deep learning and there are three subsections of the proposed method and that's are feature extraction, generating trained networks and last of all is classification. They have trained 3000 images with a different type of disease as cercospora leaf spot and alternaria leaf spot and mosaic virus. They have achieved an overall accuracy of 95.26% for using Convolutional neural Network(CNN). This (Devi & Neelamegam, 2018) is Image processing based research papers for classifying the rice plant leaf diseases and They have used multiple classifier algorithm for predicting the rice leaf disease. They mainly used KNN(K-Nearest Neighbours) classifier, ANN(Artificial Neural Networks) classifier, Naive Bayesian classifier, SVM(Suport Vector Machine) classifier and SVM classifier algorithm performs better than others which accuracy is 98.63%, then Naive Bayesian classifier algorithms which perform less then SMV and Naive Bayesian classifier algorithms accuracy is 85%. They mainly classification the disease as healthy, leaf blast, brown spot and false smut. This (Rangarajan & Purushothaman, 2020) is a classification of eggplant using the pre-trained

method as VGG16 which is keras module and also use MSVM(Multicategory Support Vector Machine). They mainly predict and classify disease of eggplant for reducing the loss for farmers. They are able to achieve 99.4% accuracy. VGG16 is also used as feature extraction and they do it successfully with better accuracy. They split the dataset into two category as Training and testing and for training they fixed 80% data and for testing taken 20% data and use VGG16 is for feature extraction and then use MSVM is for classification for testing dataset. In (Bhagat, Kumar, Mahmood, Pati, & Kumar, 2020) this disease classification model using CNN(Convolutional Neural Network) of Bell Pepper Leaf. For using Convolutional Neural Network it takes a too short time to predict Peppers leaf as disease or disease free leaves. . For the purpose of leaves disease detection, they achieved 96.78% accuracy as test accuracy. They recognize perfectly to the input image data as disease affected leaf of Bell Pepper leaf of healthy leaf. This (Maggay, 2020) is an eggplant disease prediction and recognition system using the Image Processing technique and based on Mobile-Based. They have used total 2465 images while they captured 1710 images data and collect 792 images of data from the internet. For Using the MobileNetV2 pre-trained model they fixed the target size of the image dataset as 244x244 pixel and this is RGB value with 3-dimention matrix of image dataset.

III. System Architecture

The Convolution Neural network (CNN) architecture of the "Deep Learning-Based Malabar scab leaves Disease Classification and Prediction System" for classification of Malabar scab disease is shown in Fig-1. From the very beginning of Malabar cultivation, Farmers have been suffering from Malabar scab leaves disease. Most of the diseases of Malabar are in the leaves scab disease. This is why our model will be very helpful for detecting scab leaves disease.

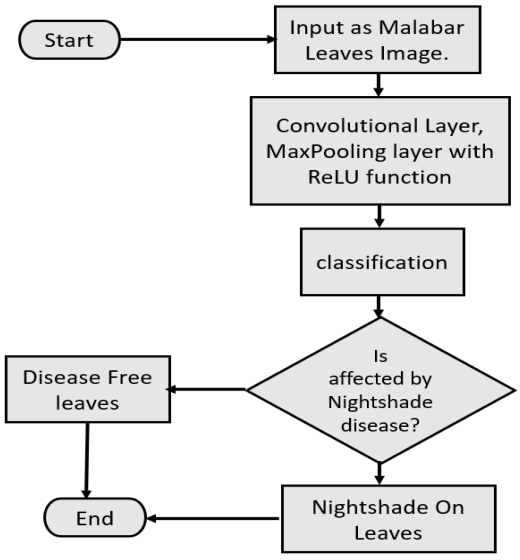

Fig-1: Flowchart of Malabar Scab Leaves Detection

Now, From the flowchart (Fig-1) of the Malabar scab disease detection is clear to us that, first of all, It's need to take Malabar leaves images as input. Then Convolutional layer, MaxPooling layer, and ReLu layer of Convolutional Neural Network's (CNN) hidden layer work for resizing input image, preprocess and feature extraction. After the Hidden layer it works in the classification section for classifying the Malabar disease as "Scab on leaves" or "Disease free leaves". The above flow chart provides the complete classification systems to predict the scab disease of Malabar leaves and Our Convolutional Neural Networks as deep learning based is able to predict so faster than the other model which has already been published by various researchers. So, it will be the fastest and most accurate solution for the Malabar cultivating farmers and so that they are able to make the decision about Malabar scab leaves disease.

IV. Methodology

We mainly discuss here about the methodology which method, techniques, and packages, module, we have used.

IV.I Convolutional Neural Network

CNN defines Convolution Neural Network is one part of deep learning which takes the input as Malabar leaves image and the main advantage of Convolutional Neural Network is used to detect the important feature without human's supervision and CNN works to detect scab leaves disease of Malabar.

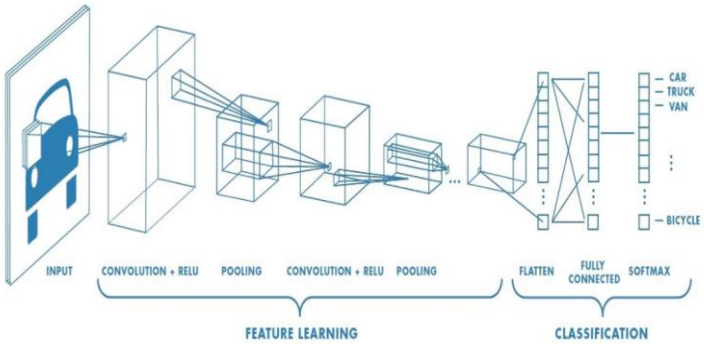

Fig-2: Convolutional Neural network (CNN) architecture

IV.II Convolutional Layer

The convolution layer is one of the important building blocks used in CNN and it filters input images as Malabar leaves and input results provide the map of activations called as a feature map and also indicating locations. So that is ready for the next step.

IV.III MaxPooling Layer

The MaxPooling is another most important part of Convolutional Neural Network which reduces the output

parameters and also reduces the spatial size. MaxPooling layers operate on each feature map and are also used for feature extraction of the image input and it extracts our own Malabar image dataset.

IV.IV FLATTEN

Flatten is a function that converts the pooled feature into a single column and it is part of the fully connected layer. Converting into a single column means our Malabar dataset converts into a 1-dimensional array for the input. And it is also called a fully connected layer and connected with the final classification model.

IV.V DENSE LAYER

The dense layer is an actual network layer in a model and it provides the output from the previous layer and also every neuron provides one output to the next layer. Suppose is Dense(512) then it has 512 neurons and our model has also 512 neurons and the last dense layer has 513 neurons.

V. IMPLEMENTATION

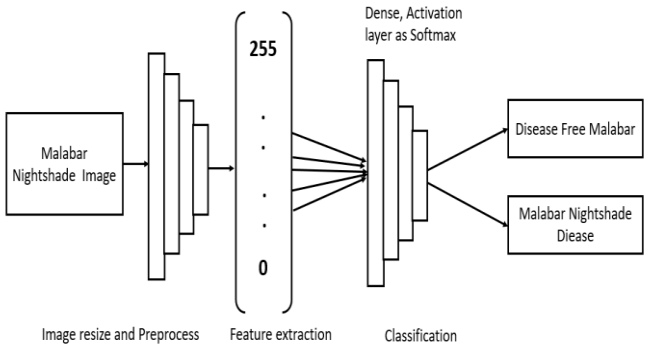

Fig-3: Malabar Nightshade Disease Detection model via CNN

This is the Malabar Nightshade Disease detection model using CNN as deep learning techniques and first of all Convolution Layer is used to build the main blocks after taking Malabar image as input and always it will take 200x200x3 size of the input image and also mapping the feature of input image then MaxPooling2D layer is used for feature extraction and is used for reducing the output shape of the CNN model and we also use sequential model. Then flatten is used for converting into a single column and dense layer is for classification. Where also the learnable layer and max_pooling layer is not the learning able layer.

$$n_H = n_W = \frac{n + 2p - f}{s} + 1$$

Fig-4: Convolutional Neural Network model's output shape changes rules

From Fig-4,
Size of Height(nH) = 200 (Initially we defines the input image shape as height),
Size of Width(nW) = 200 (Initially we defines the input image shape as width),
Padding (p) = 0,
Kernel shape / batch size = 3,
Stride (s) = 1

This equation is defined where Convolutional Neural Network is a sequential model and using the kears API. We have fixed target_size as (200x200) and batch size is 3 and this is define the training image malabar dataset, validation image malabar dataset and also for testing image malabar dataset. So, all the images are converted into the same shape which must have in the Convolutional Neural Network.

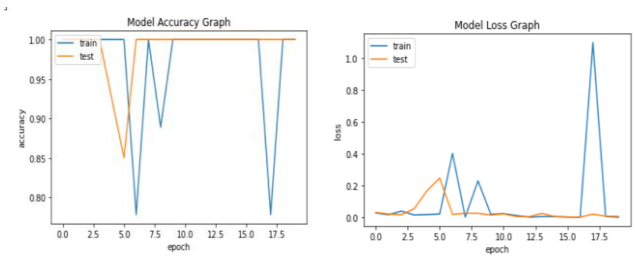

Fig-5: Model Accuracy and Loss graph

Fig-5 short way to notice the performs of the model and our model based on CNN performs better and provides better accuracy and also with less loss of a model.

TP **14**	FN **1**
FP **0**	TN **16**

Fig-6: Confusion Matrix

We have used a total 31 images for testing and Fig-6 defines the confusion matrix of our model. Below the value of accuracy, Recall, Precision, f1 Score,

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN} = \frac{14 + 16}{14 + 16 + 0 + 1}$$

$$= 0.9677419$$

$$\text{Recall} = \frac{TP}{TP + FN} = \frac{14}{14 + 1}$$

$$= 0.93333$$

$$\text{Precision} = \frac{TP}{TP + FP} = \frac{14}{14+0}$$

$$= 1.0$$

$$\text{F1 score} = 2 \times \frac{\text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}} = 2 \times \frac{1.0 * 0.9333}{1.0 + 0.9333}$$

$$= 0.965499$$

The better F1 score defines the better accurate model and our models defines 0.965499 F1 score which is too better.

V.I Feature Extraction

In this approach, we have used the Convolutional Neural Network (CNN) where the target input image is 200x200 and after building the blocks and mapping the input image as feature mapping. Feature mapping is the preprocessing of the input images for feature extraction. After feature mapping, it extracts the feature of the input image and it's done by max_pooling layer. Max_pooling layer manly used to reduce the model output shape and also for feature extraction. Feature extraction is highlighted in Fig-3 which were fixed the input image target-size must be in (255-0) with respect to ImageDataGenerator function and after the feature extraction, the trained data are ready for next step as classification and feature extraction has happened in the hidden layer.

V.II Classification

After the feature extraction, it defines the classification part and it is the main part so that it provides the output as disease leaves or disease free leaves. After feature extraction by max_pooling, flatten is convert the extracted feature into a single column. Dense layer and Softmax provide output as Malabar Nightshade Disease or Disease free Malabar. From Fig-3, Input image of Malabar nightshade is taken with target_size of 200x200 and resize then preprocess, then feature extraction and then flatten and finally dense layer and softmax makes the classification and provides output as Malabar Nightshade Disease or disease free Malabar. This is also known as output part of the model which makes the decision of the disease or not.

VI. Dataset Description

This is one of the most important parts of our research approach. Because this is the part that exactly defines our research goal There are various types of malabar disease of malabar but we made a classification either Malabar Nightshade disease nor Disease Free Malabar. We trained our own dataset so that it can perfectly detect the Malabar Nightshade Disease. For the reason to select the disease as Nightshade is most common and mostly affected by Nightshade disease of malabar. From the Fi-3, It's successfully classified into Disease Free Malabar or Malabar Nightshade Disease.

VII. Result Analysis

We have made a prediction on Malabar dataset using Convolutional Neural Network(CNN) and we mainly focus on Nightshade disease of Malabar and finally we could do it with training accuracy is 100% (we take the last training accuracy), validation accuracy is 100% (we take the last validation accuracy) and testing means overall accuracy is 96.77% and we have used 30 epochs for training our model. After Training our model below the Table of accuracy is Training, Validation and Testing.

Training Accuracy(last accuracy)	Validation Accuracy(last accuracy)	Testing / Overall accuracy
100%	100%	96.77%

Table-2: Accuracy

From table-2, It's pretty much accurate and also from Fig-5, it's clear that we are able to make a better model for recognition of Malabar Nightshade disease or disease free Malabar. Below some of the leaves which we have used for testing our model.

Fig-6: Disease Free Malabar data from the test dataset

Fig-6: Malabar Nightshade Disease data from the test dataset

VIII. Future Scope

Our Malabar Nightshade disease recognition model based on deep learning is perform on Malabar Leaves when it will be Nightshade disease then it must provide a result as Malabar Nightshade disease otherwise it will be fresh Malabar leaves. We have a plan to deploy it in Web-browser and also for android using tensorflow object detection. We used the same trained model for saving the trained model as model.h5. Then we can use it in tensorflow object detection and it will be easy to control in web applications and also for android applications for deploying.

IX. Conclusion

Malabar Nightshade disease recognition and the prediction techniques using CNN and our Malabar Nightshade disease

model perform better with 96.77% which is relatively better than other models of Malabar leaves disease recognition and classification model. We also design this model as a helper of village farmers who are reft from the agriculture office's suggestions. For using our model they easily can detect the Malabar Nightshade disease on leaves and it also consumes time for them and also helps them for taking the decision urgently.

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