

# Diseased Portion Classification & Recognition of Cotton Plants using Convolution Neural Networks

Prashant Udawant, Pravin Srinath



**Abstract:** Cotton plant is one of the cash crops in India. For more profit its intense care is necessary. Many researchers are using machine learning for early detections of cotton plant disease. Convolution neural network (CNN) is a deep feed forward artificial neural network. This algorithm is little faster as compared to other classification algorithms. In this paper, CNN is used for classification of the diseased portion of cotton plant images. The result shows that the model used classifies the healthy and diseased cotton leaves more accurately.

**Index Terms:** Convolution Neural Network (CNN), Support Vector Machine (SVM), Multilayer Perceptron (MLP), Rectified Linear Unit (RELU)

## I. INTRODUCTION

India is one of the countries where agriculture is main business. In India approximately 80% population's source of income depends on farming. At global level, lot of technological advancement has been happening in different fields of business. In developing countries like India lot of efforts are being taken for increasing the profit through agriculture. However, the agricultural production of the nation is hugely affected by the usage of pests during the various stages of production. Using technology for detection and identification of the plant diseases rather than following the conventional methodology of manual observation of plants by the farmers or experts can lead to accurate, less time-consuming as well as inexpensive identification process. Computer Vision advancements, especially, Image processing can be thus used for the same. This is easy to implement and not only it enhances the practice of precise plant protection but also expands the computer vision application market in fields of precision agriculture [1].

There are many factors that cause disease in plants, if the cause could be detected at early stages, it may be possible to cure without spreading it to other plants. The major cause for harm is fungal, bacterial and viral diseases. Several research is going on for the detection of disease using image processing that depends on different causes like sunlight, weather condition, use of pesticide[2]. Early detection and treatment of plant diseases with the help of suitable management techniques with sequence of processes such as acquiring image, preprocessing this image for feature extraction and classification to detect and control growth of disease [3]. Usage of artificial neural network techniques is done for detecting leaf diseases and selection of fertilizers in an easily determinable manner. In today's research revolution deep learning is playing a vital role. Deep convolution neural network has been used for apple leaf diseases. This technique used for generating diseased images and designing a architecture of deep CNN [5]. Deep learning has become an emerging topic along with CNN. Plant images is an input for the convolution neural network. Images with unhealthy plant contain characteristic which differentiate them from healthy plants. These characteristics can be in form of patterns, colors, status of infection, location present in the plant, etc. The neurons activation in CNN is based on the information of color or pattern of the image. These characteristics can be studied to identify whether they are infected or healthy [6]. Jianxin Wu gave a detailed and mathematical approach to Convolutional Neural Network (CNN). The architecture and the different layers of the CNN like The ReLU layer, the convolution layer, the pooling layer have been explained in this report. A brief description of stochastic gradient descent (SGD) has been enlisted [7]. CNN is useful in identifying the species of a plant from image of its flower using the fact that the appearance of flower is easily distinguishable and also the features of flower are stable and less prone to change with the changes in surrounding. To implement the CNN appropriate network selection is important, which is decided by comparative study of well known CNNs and then deciding which one to implement[8]. Basically, the automatic disease diagnosis is technically feasible which requires deep learning. There are mainly two main architectures that are been focused namely AlexNet and GoogleNet. The AlexNet architecture provides the similar architecture as LeNet-5 which consists of 5 convolution layers also followed by 3 connected layers which end with the soft max layer.

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From the 5 convolution layer, the first 2 are followed by a normalization and a pooling layer and the last one with the single pooling layer. The 38 outputs from the connected layer feed the SoftMax layers. The AlexNet architecture provides the similar architecture as LeNet-5 which consists of five CNN layers also followed by 3 fully connected layers which conclude using soft max layer. From the 5 CNN layer, the first 2 are followed by a normalization and a max pooling layer and ending with the single pooling layer. The 38 outputs from the connected layer feed the SoftMax layers.

Non-linearity activation unit is linked with first 7 layers of AlexNet, while the dropout layer is related with the first two fully-connected layer having a dropout ratio of 0.5. Unlike AlexNet, GoogleNet architecture consists of 22 layers with lower number of parameters [9]. Plant leaf and disease detection can be done by using methods like HSV and SVM with the classifications of diseases in plant leaf. Background segmentation is used to segment the diseased part of the leaf and separate it from the unwanted part [10]. Growing convolution neural network can be used to find out the proper number of training samples that are required. From the plant dataset, Growing Convolution Neural Network outperforms the other traditional methods of plant leaf identification and detection [11]. Even concept of Convolutional Neural Networks (CNN) and deep learning is used to detect the plant diseases and the leaves that are infected by the insects. Specifically, this paper aims to deal with diseases and pests that affect in plants. Deep learning is based on the complete large dataset that can be referred and analyzed [12]. There are many techniques for plant identification based on Deep CNN not only for the identification of plant leaf diseases but on a broader level. The learning capability must be trained in specific domain instead of general domain which is a challenging area of Plant Identification Task [13]. To improve model accuracy, generalize and prevent over fitting, various techniques have been applied. The planned approach have been assessed in LifeCLEF 2017 campaign which can be used via PlantNet or naturblick (mobile application) for education. The techniques of deep learning addresses plant identification task because they already convince to be a successful technique for classifying image based on the object in different scenario. One of the examples is DCNN which is a powerful tool to identify objects in images and is also capable of handling the large amount of noise in the training set [14].

## II. CONVOLUTION NEURAL NETWORK

Convolution Neural network (CNN) is easy to implement and it not only enhances the practice of precise plant protection but also expands the computer vision application market in fields of precision agriculture. The steps for disease recognition model are 1. Creating a database by gathering images. 2. Creating a deep learning framework for CNN training. The specialty of this model is its simplicity and also the ability to distinguish between the healthy and diseased leaves by using CNN. Convolution Layer is the first and core layer in CNN. The input given in our model is 128 x 128 x 1 array of pixel values which is a grayscale image. 32 filters are being used in the first convolution layer having kernel size of 3x3. It consists set of learnable filters or kernels having small receptive field which can be extended for the full depth. In the forward pass on the network, the width and height of the input volume is combined using the filter, the next step is to

evaluate the dot product among the entries of these filters and the input. This leads to production of 2D activation map of these filter. This makes the network capable of learning filters which activates only when some specific feature is present at input on some spatial position. The proposed method uses 'ReLU' activation function on the initial layer and 'Tanh' activation layer in convolution layer present in between. The number of filters used in the layer defines the activation map depth and provides more information about the input volume. The padding used is same which implies that the image will be padded with sufficient 0's at the edges to keep output size which can be reduced due to increase in kernel size. Activation Layer controls the process of signal flowing from one layer to another for imitating the process used for firing of neurons in our brain. More neurons will be activated only if the output signal coming is more strongly related to the past references which makes them efficient for identification. This model uses three activation functions a) ReLU also known as Rectified Linear Unit b) Tanh c) Softmax. These activation functions are used for propagating signals in the model. Output produced from the convolution layer is an array having the most interesting features mapped from the original image which still is a pretty big array. This layer is useful for down sampling the image i.e. reducing the size of the array. This process helps for reducing the over fitting problem by supplying an abstracted form of the illustration to next layer. This process is accomplished by applying a filter (max) to non-overlapping sub-regions of the initial illustration. It is an application of the moving window over 2D image in which the maximum value in that window is the input to the next layer. This generalizes the results from the convolution which make the detection more significant without dependence on the scale and orientation of the image. Dropout layer in the neural can be simply explained as the dropping out visible and hidden units. In machine learning, dropout is the way of regularization which result in prevention of over fitting problem by adding a penalty to the present loss function. By doing so, the interdependent set of features weights are not utilized in the process of training the model.

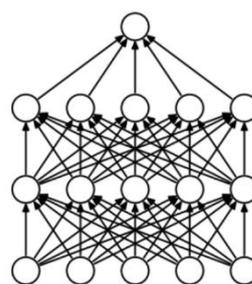


Fig. 1a Standard Neural Net

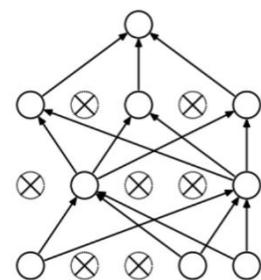


Fig. 1b After applying Dropout Layer

Fig. 1a shows standard neural consisting of the all neurons interconnected with each other while Fig. 1b shows neural network after applying the dropout layer which have only the important nodes present which reduces the processing power of the system and also the problem of over fitting.

### III. ACTIVATION FUNCTION

Activation function is a node which is added at output end of neural network. It is also called Transfer function. It is mainly used in analyzing the final output whether it is yes or no. It is observed that activation function increases the complexity of the model. But using activation function has its own advantages. In the absence of activation function the weight and bias in the neural network would perform linear transformation. Linear equations are easy to solve but it cannot perform complex equations. Non Linear activation functions are the most used activation functions. It is easy for this model to adapt with variety of data and to differentiate between the outputs. These functions are divided based on their range or curves. Tanh function is similar to sigmoid function. It is scaled version of the sigmoid function. It is defined as,  $\tanh(x) = 2 / (1 + e^{(-2x)}) - 1$ . The range of this function is from -1 to 1. It is continuous and differentiable in nature. As the function is non-linear, we can back propagate the errors. The derivative of tanh is given as,  $f'(x) = 1 - \tanh^2(x)$ . ReLU is used in designing most neural networks. Similar to above functions described above ReLU is also non-linear in nature, we can back propagate the errors. The main advantage of using the ReLU function is that unlike in other function neurons are not activated at the same time. All, the negative input values are converted into zero and neurons are not activated. This makes the network scattered that makes it simple and efficient for computation.

The derivative of ReLU function is given as,  
 $f'(x) = 1, x > 0$   
 $= 0, x < 0$

Here same condition is seen in ReLU i.e. vanishing gradient problem. For activations in negative region of 'x', the derivative is zero and weights are not updated while performing back propagation. Softmax function is useful when we are dealing with classification problems. The sigmoid function was only able to classify to for two classes. While in case of Softmax function, it would compress the outputs for each class between zero and one and then divide by the sum of the outputs. This would give the probability that input is in which class.

### IV. RESULT ANALYSIS

Training accuracy Vs Validation accuracy Training accuracy signifies how well the network is being trained by the given dataset on every epoch. In our case, number of epochs to train the model is 1000. Here x-axis represents number of epoch whereas y-axis shows the accuracy, where 1 is the highest accuracy and 0 is the lowest which signifies scope of improvement. In fig 2 graph, blue line denotes the training accuracy with respect to each epoch. Validation accuracy signifies how well the model is able to predict the output for given input. This accuracy is measured using the validation set. In our proposed model, the data is shuffled every time before the validation and training dataset. This helps to make sure that same set of images are not used for training and validating images. This increases accuracy of the model, every time when the model is trained.

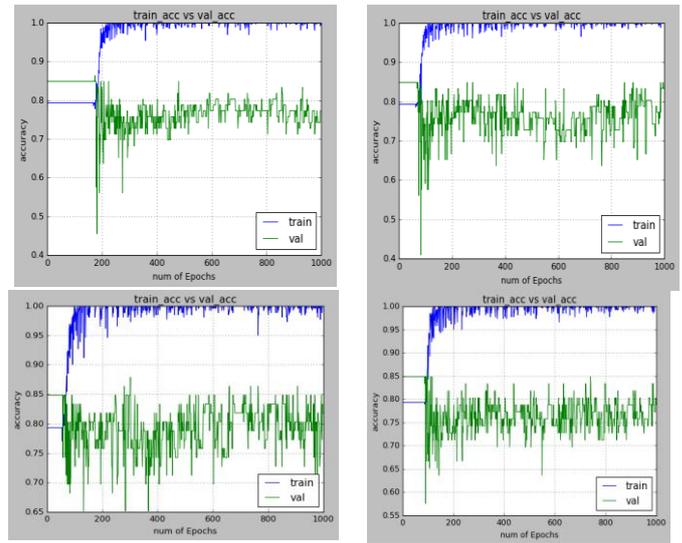


Fig 2. Training Accuracy Vs Validation Accuracy

### V. CONFUSION MATRIX

Confusion matrix is being used for summarizing the performance of the proposed model.

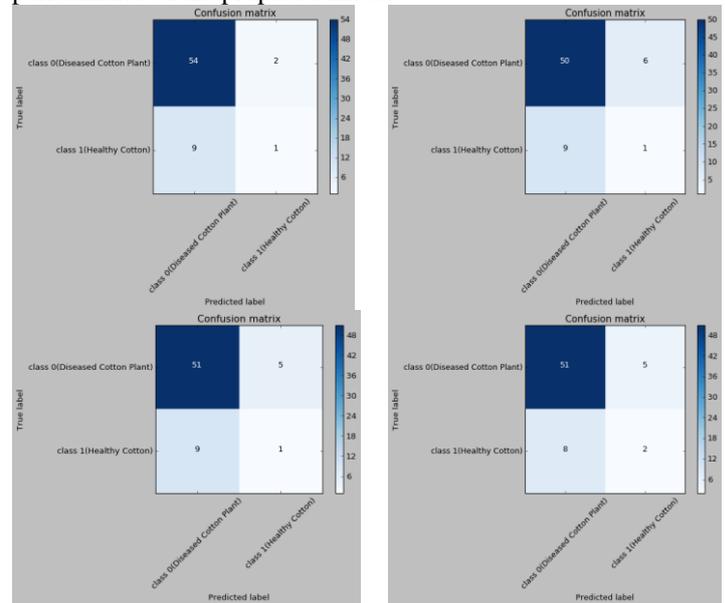


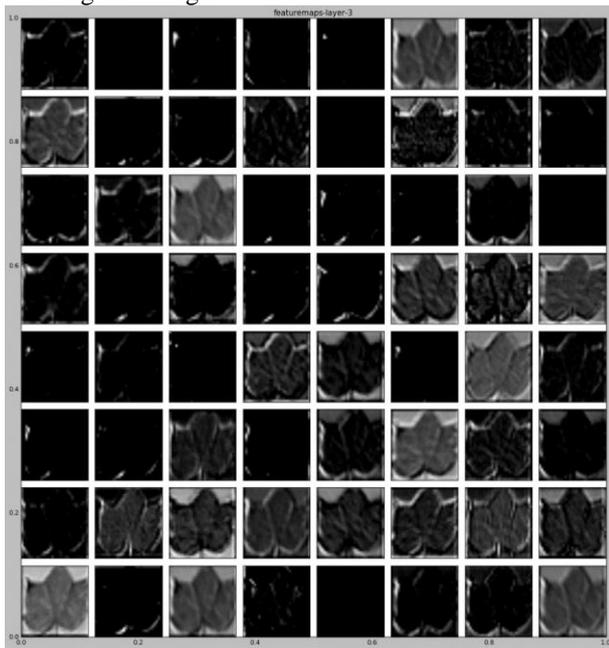
Fig 3. Confusion matrix

It helps us to distinguish between the accuracy by which the model can be classified for each class. It gives an idea of how the model will perform for real world samples. It uses two measures, true label and predicted label for generation of the matrix. True label is the actual class of the image while predicted label is output provided by the model on the given input whose actual class is the true label. Our proposed model is able to identify both diseased and healthy cotton. Confusion matrix is improved after each time the model is trained which can be seen in the Fig 3.

	Predicted Label (1)	Predicted Label (2)
True Label (1)	True Negative	False Positive
True Label (2)	False Negative	True Positive

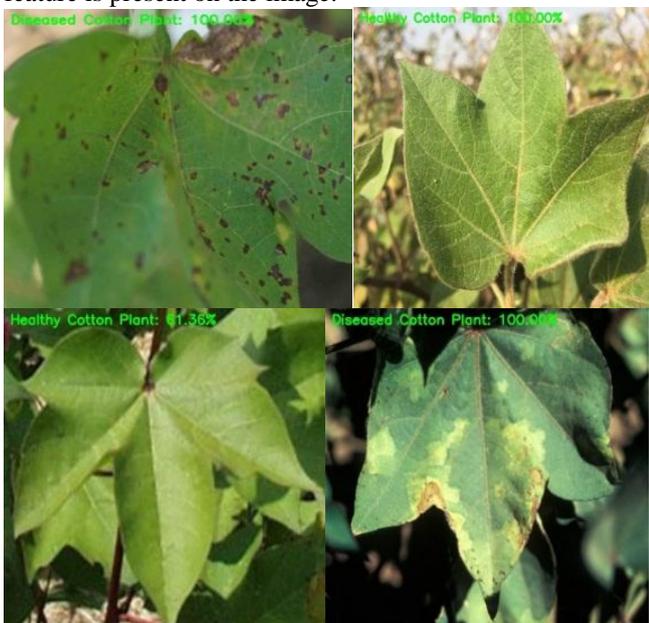
## VI. FEATURE MAP

The feature map is used for analyzing the important features from the given image.



**Fig 4. Feature maps for layer 3**

The images mentioned in Fig.4 shows feature maps for the layer-3 of our current model being trained. In the figure the layer is able detects the shape of leaf. It is also known as activation map as it corresponds to the activation of different portions of the image. High activation signifies that certain feature is present on the image.



**Fig 5. Predicted results for the test images**

Fig 5. shows the predicted results for the cotton images used for testing the trained model.

## VII. CONCLUSION

This research paper proposes a deep CNN model for accurately identifying Cotton Leaf image as diseased or healthy. It is an improved method over the Regular Neural Network to predict the result. This model provides a high

accuracy result to classify Cotton Leaf. The results obtained using the model indicates a high accuracy rate to differentiate between healthy and diseased cotton plant.

In addition, the restriction of biological growth in the surrounding region has caused difficulty for the collection limiting the model to classify image in two classes (healthy and diseased). This model will be further improved in the future after a collection of dataset and by using better model like faster RCNN(Regions Convolution Neural Network) and SSD(Single Shot MultiBox Detector)

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