JUTE LEAF DISEASE PREDICTION USING DEEP NEURAL NETWORK

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ABSTRACT

Deep convolutional neural network is a diverting area where research researches and achievement are taking geometrical progress in the agriculture field. Various researches are going on vigorously in plant diseases detection. Plant contribution is highly important for human life and environment. Plants also suffer from diseases as human and animals. There are many plant diseases that occurs and affected natural growth of plant. These diseases infected complete plants including leaf, stem, root, fruit and flowers. This research propose is a diseases detection and classification technique with the help of Deep learning convolution neural network. The latest generation of convolutional neural networks (CNNs) has gained magnificent results in the field of image classification. This research is related with a new approach to the development of plant disease detection model, based on leaf image classification, by using deep convolutional neural networks (DCNN). All essential steps required for implementing this disease detection model is fully discussed throughout the report, starting from collecting images in order to generate a dataset, evaluated by agricultural experts. This research is mainly focused how to detect jute plant leaves diseases using training and testing data using Deep learning convolution neural network (DCNN), stable and dataset.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Jute dicotyledonous fiber- bestowing plant of the genus corchorus, order tiliaceae. Jute is famous for its name ‘Golden Fiber’ in Bangladesh. Jute was the most important cash crop of the country. Jute fiber is produce mainly from two commercially important species, namely white jute (corchours capsularis) and tossa jute (corchorus olitorius). They are grown in Bangladesh, India, Malaysia, Nepal, China, Taiwan, Thailand, Vietnam, Combodia, Brazil and some others countries. In Bangladesh agriculture jute is the main crops for cultivate. But in our country jute are damages by many diseases and other reason. For example, 40% to 50% jute plant may destroy in the field due to leaf diseases. In plant leaves are the main part in which plant. Leaves can be addressed as the core part of the plant, it is only with the help of leaves the course of photosynthesis can be performed. If the plant leaf is infected by disease it directly effects the plant life cycle. So to reduce the leaves diseases we have to do better something to control this. To control these diseases we use various techniques such as Image Processing techniques, Machine Learning, Support Vector Machine (SVM), Deep convolutional neural networks (CNN), Probabilistic Neural networks (PNN) .In our research we use Deep Convolutional neural networks (CNN) to detect our desire diseases. We are attempting to develop a system that will defect the diseases of jute plant through Deep convolutional neural networks. The method described in this paper is a new approach in detecting plant diseases using the deep convolutional neural network trained and fine-tuned to fit accurately to the database of a plant’s leaves that was gathered independently for various plant diseases. The advance and originality of the developed model lie in its clearness; healthy leaves and background images are in line with other classes, enabling the model to differentiate between diseased leaves and healthy ones or from the environment by using deep CNN. Learning efficient image representations is at the root of the scene classification task of remote sensing imagery. The existing methods for solving the image classification task, based on either feature coding approaches with low-level hand-engineered features or unsupervised feature learning, can only generate mid-level image features with limited representative ability, which essentially prevents them from achieving better performance. Recently, the deep convolutional

neural networks (CNN), which are hierarchical architectures trained on large-scale datasets, have shown astonish performance in object recognition and detection. In deep convolutional neural networks method we detect jute leaves diseases by some affected leaves. We put some image for training and testing and show the accuracy of the image result after detected. In our study, we escapade the deep learning method for plant disease recognition, driven by evolvement of deep learning techniques and their application in practice.

1.2 Problem Statement

Since jute is the main cash crop of the farmers, they had to sale in order to meet family needs. Our country earn a huge amount of foreign currency from jute and jute products. But day by day the cultivation of jute is very less because of some said diseases problem. As a result the low market price and low demand of jute have been the major problem of the jute growers. All of the diseases farmers do not have enough knowledge how to grading jute fiber fortunately. Our government has stepped forward to revive the good times of this promising crop. On the other hand many research have been guided for plant disease deletion using convolutional neural networks (CNN). We try to jute plant leaves disease detect using convolutional neural networks and machine learning tools. For this farmer is being helped for growth huge jute to reduce the jute leaves diseases. However, no such work has been done for jute plant leaves. Jute is known as the golden fiber in our country. Every year we export large amount of jute in other country and earn lot of foreign currency. We also made many products by jute. Jute based products are put to a wide range of use. But jute leaves diseases are harm to all this sector.so we are motivated to reduce the diseases and try to farmer to help more cultivate jute for all benefits. If the disease are not Detected early and correctly, then the farmer have to undergo huge losses.it is not always possible to perfectly identify the diseases as it requires a lot of experience and knowledge.

1.3 Research Question

- Can technology improve the amount of Jute cultivation?
- How beneficial it would be if we predict Jute leaf disease using technology?

1.4 Research Outcome

Now-a-days technology is developing rapidly. We emphasis on agricultural developing by using technology. In our research using convolutional neural networks (CNN) we try to predict the diseases of jute from leaf analysis. In future we also develop an mobile application where farmers can directly identify the effected leaf and the way to remedies of the disease. And jute cultivation will increase.

1.5 Report Layout

Chapter-2 Contains the Related work for development of the current system, which includes the detailed aspects of the targeted jute leaf diseases. Chapter-3 Presents the Proposed Methodology for our system. It includes system design, technology, mobile application analysis, various figures and diagrams that were used for designing and developing our system. Chapter-4 Analysis the results of the research and a short discussion on it. Chapter-5 Contains the future works that we want to develop and conclusion

CHAPTER 2

RELATED WORKS

2.1 Related works

Diseases detection using convolutional neural networks (CNN) machine learning tools in works also have done on different plants. Many researchers have work on both traditional and soft computing approaches for the segmentation of infected area of plant from diseases. But do not work of taking jute leaves. Another plant such as rice, tomato, Brinjal etc are also used to in experiment we show some number of soft computing methods that have been used to identify the diseases of the plant.

2.2 Research Summary

From the table 2.2.1 we see many related work to identification many plant diseases in various methodology. After study all those paper we can give a description about all their work. Generally it has been seen from the literature that image processing methods has been applied for the identification of plant diseases. Where the learning ability of Neural Network (NN) also contributes for the identical purpose. As it seen from the survey authors have majorly targeted on the identification of a diseases from the particular plant because it is a hard task to identify and categorize the disease among different categories. There are number of application using image processing techniques have been presented like Tallha Akram et al. use it for identification of plant diseases and it's accuracy was 80%. There are number of application using K-means clustering have been presented like Shanwen Zhang et al. use it for identification cucumber leaf diseases. Another application was use Fuzzy c means and support vector machine have been presented like Megha.S et al. use it for identification of plant leaf diseases and accuracy was 82%. There are also application using Bank propagation algorithm, genetic algorithm and rough theory have been presented like Santnu Phadikar et al. use it for identification of rice leaf diseases it's accuracy was also good. So here the short summary of related works which we are study before.

TABLE 2.2.1: REVIEW OF PLANT DISEASES USING SOFT COMPUTING METHODS

Authors	Methodology	Application area	Accuracy(%)
Tallha Akram et al	Based on image processing technique	Real time classification of plant diseases	80%
Shanwen Zhang et al.	K-means clustering	Identification of cucumber leaf disease	75%
Megha. S et al.	Fuzzy c means and support Vector machine	Identification of plant leaf disease	82%
Jayamala Kumar Patil et al.	Content based image retrieval	Identification soya bean leaf disease	79%
Faiza Nuzhat Joyee et al.	Image processing technique	Jute stem disease detection	80%
Pranjali B. Padol et al.	Support vector machine	Identification grape leaf disease	74.6%
Malvika Ranjah et al.	Anti-facial neural network	Identification cotton leaf disease	81.3%
Ramakrishnan. Mp. et al.	Back propagation algorithm	Identification of ground daunt of leaf disease	65.7%
Santanu Phadikar et al.	Genetic algorithm and rough theory	Identification of rice leaf disease	78%
Marion Neumann et al.	Support vector machine	Identification of beet leaf disease	81.2%

[4]

2.3 Disease analysis

Different types of disease have been identified in jute. Among them we have chosen the disease of leaf. Here is the description of the disease [3].

i. Powdery mildew: It is a fungal disease that affects a wide range of plants. At the last of jute season fine white powdery mass seems to be accrued on leaf surface resulting fall of leaves. Foggy climate is favorable for the growth. Disease disseminated by using seed, soil and air. Deshi and Tossa jute infected through this disease.

Figure 2.3.1: Powdery Mildew

Control:

Spraying of thiovit @ 32g/10 liters water just to see the symptoms.

ii. Leaf mosaic:

Yellow mosaic spots regular or irregular appear commonly on Capsularis plants at any stage of growth affecting formation of chlorophyll. Disease disseminated by seed, soil and air. Deshi and Tossa jute infected through this disease.

Figure 2.3.2: Leaf mosaic

Control:

• Uprooting of infected plants

• Spraying of Heyzine/Hemithrin @ 15ml/10 litre swater 2-3 times with 7 days interval.

iii. Leaf curling:

Due to leaf curling, the plants become pale, leaves turn into thick and rough. Due to leaf yellowing the top leaves of the plants become yellowish, mosaic pattern of green and yellow in which either the colour remain predominant.Disease disseminated by seed, soil and air. Deshi and Tossa jute infected by this disease.

Figure 3.2.3: Leaf curling

Control:

• This disease can also be controlled by seed treatment using garlic paste. Before sowing seed should be treated with 125gms garlic paste per kg seed. After seed treatment with garlic paste seed should be dried in the sun for three days.

CHAPTER 3

PROPOSED METHODOLOGY

The entire process of developing the model for plant disease identification using deep CNN is described here in detail. The complete process is divided into few essential steps, starting with recruitment of images for classification process using deep neural networks.

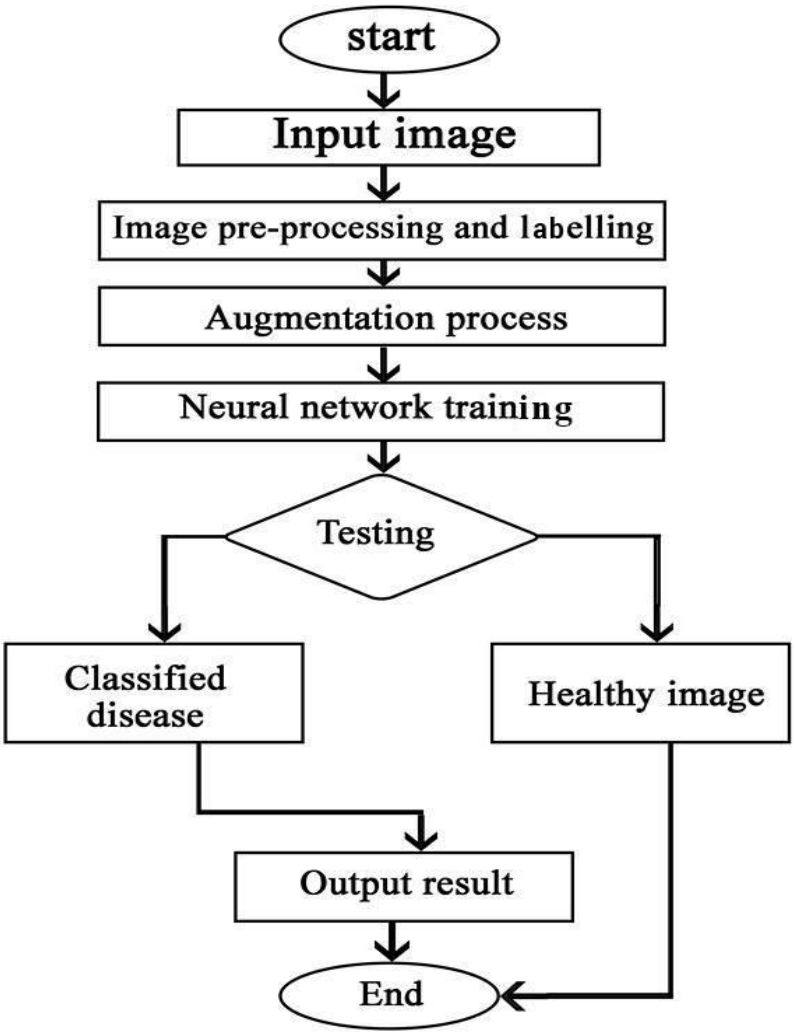

Figure 3: Flowchart

3.1 Dataset

Adequate datasets are requisite for all steps of object detection research, beginning from training phase to evaluating the performance of recognition algorithms. All the images collected for the dataset were captured by camera, downloaded from the internet, searched by disease and plant name on different sources.

We have used various class for various diseases. Also used another class for distinguish healthy leaves from the infected leaves. We have used here 3 types of jute leaf disease

Then we have removed all the duplicate Images using python script applying the comparing procedure. The script removed the duplicate image.

In the next step, we tried to improve our data set by augmented images. The main target of our research is to train of the network to learn the properties that differentiate one class from the other classes. As we used more augmented images, the possibility for the network to learn the adequate features has been increased.

3.2 Image Preprocessing and Labelling

Image captured by the camera and downloaded from the internet wire in various sizes, formats and resolutions. In order to achieve better feature extraction , the ultimate images design to be used as data set for deep neural network classifier were preprocessed in order to reach constancy . Then crop the image manually in order to mark the infected region of the jute leaves. We ensured that the images content all needed information for feature learning. We resize the image to 256*256 to reduce the training time. The training time we calculated by the written script in the Python, using the openCV framework [5].

Previously we have taken some classes in the dataset. From the help of Agricultural experts, we have labelled all the images with appropriate disease name. Now we gather any group images into the classes discussed in section 3.1. Also removed the duplicated and unwanted images from the dataset. This way we accurately classified the images for the training and validate the dataset.

3.3 Augmentation

We used augmentation to increase dataset and neglect distortion which helps to reduce over fitting while the training step. In machine learning and statistics over fitting occurs when the statistical model recounts random noise or error rather than underlying relationship [6]. Image augmentation consists of some transformation techniques containing affine transformation, perspective transformation and rotations. Affine transformation used to reveal translation and rotation [7]. For this process we rotate the image in various degrees.

In Figure 3.3.1, we have shown the transformation of augmentation process. In this stage we used to particular application developed in C++ using the openCV library [8] , in order to automate the augmentation process for many images from the dataset with chance of shifting the parameters of transformation in the run time which enhances flexibility .

Figure 3.2.1: Augmentation transformation processes

3.4 Neural Network Training

To identify the infected leaves from the healthy leaves we have used Deep Convolutional Neural Network (DCNN) method. To develop an images classification Model, trained the DCNN form the dataset described in section 3.1.

There are many deep learning frameworks, like python library Theano[9], machine learning library Lua, Torch7[10], Caffe, an open source deep learning framework developed by BVLC[11] containing caffeNet model. In our research we have used this framework as it is suitable for our research.

This framework's core is developed in c++ and also provides command line, python interfaces. By integration caffe with the cuDNN library can accelerate Caffe models [12]. CaffeNet is a deep CNN that contains multiple layers that gradually calculate features from the input image [13]. Particularly the network consists of eight learning layers, five are convolutional and three are fully connected[14]. CaffeNet architecture is deliberated as a beginning point and synthesized to support our classes. The last layer changed and the output of the Softmax layer parameterized to the necessity of our research. In the Softmax layer, classification operation is occurred.

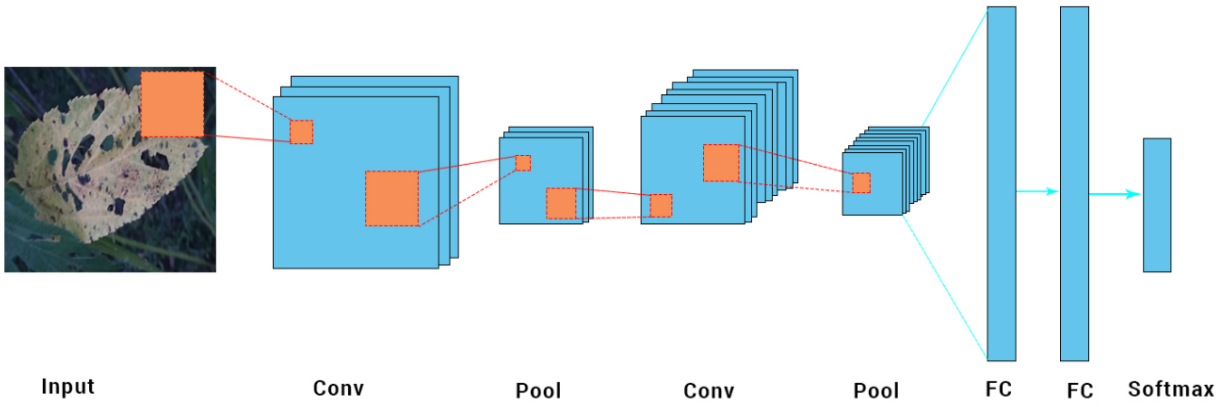

Figure 3.4.1: Convolution process

Rectified Liner Units(ReLU) is a combination and used as alternative for saturation nonlinearities. It enhances the nonlinear properties of the decision function and neural network without affecting.

Capacious field of the convolution layer. The activation function eventually learns the parameters of reformation and enhance accuracy in extra-computational cost[15].

The activation function is:

$$f(X_n)=\max(0,X_n)$$

Here,X_n stands for the input of the nonlinear activation function of on the nth channel.

The training is much faster using deep CNN with ReLU. This method is used for the output of every convolutional and fully connected layer.

Pooling layer is an important layer of CNN. It is a form of nonlinear down-sampling. Max pooling is a nonlinear function that divides the input image into a set of non-overlapping rectangular and for all sub-region output is the maximum. Pooling layer control the overfitting. Jointly ReLUs and dropout are more convenient.

3.5 Testing

Testing is very important for our research for a better performance we need a better result from testing for this purpose. We have trained the artificial neural network (ANN) with a training set and test set. The information of the training set is known.

Testing with the test set we can predict the outcomes. The accuracy of this prediction is calculated. This accuracy is showed in fig. 4.2.2. We also get a classified result.

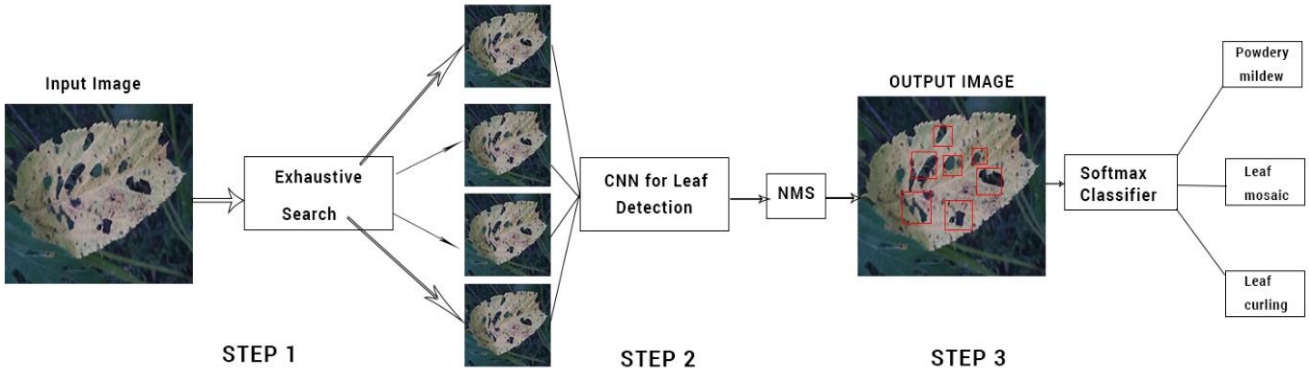

Figure 3.5.1: Overall Process

CHAPTER 4

RESULT AND DISCUSSION

4.1 Classification Performance Assessment

We performed the assessment of this classification model by nine evaluation metrics. Samples of infected jute leaf and healthy jute leaf are designated as the Infected and the Healthy class respectively. Here,

- True Positive (TP): Accurately detected i.e. Infected leaf is classified as Infected class.
- False Positive (FP): Inaccurately detected i.e. Healthy leaf is classified as Infected class.
- True Negative (TN): Accurately rejected i.e. Healthy leaf is classified as Healthy class.
- False Negative (FN): Inaccurately rejected i.e. Infected leaf is classified as Healthy class.

Evaluation metrics are defined as follows:

- Accuracy = (TP + TN) / (TP + FN + FP+ TN)
- Sensitivity = TP / (TP + FN)
- Specificity = TN / (TN + FP)
- Precision = TP / (TP + FP)
- Negative Predictive Value = TN / (TN + FN)
- False Positive Rate = FP / (FP + TN)
- False Negative Rate = FN / (FN + TP)
- Error Rate = (FP + FN) / (TP + FN + FP+ TN)
- F1-Score = (2 * (Precision * Sensitivity)) / (Precision + Sensitivity)

4.2 Results and Discussion

The results represented in this portion are related to training with the whole database containing both original and augmented images. As it is known that convolutional networks are able to learn features when trained on larger datasets, results achieved when trained with only original images will not be explored. Deep CNN has added a lightweight structure that demonstrates state-of-art resolution quality, and achieves fast speed for particular on-line usage and it also give super resolutions.

We implement deep learning technique namely Deep Convolutional Neural Network (DCNN) for detecting the infected leaf by jute disease. We have trained DCNN model for learning that it can identify the infected leaf with healthy leaf by implementation of the classification task. The python keras library has been executed to accomplish all the classification tasks.

Table 4.2.1 displays the confusion matrix of DCNN. DCNN predicts the true positive (TP) of 49, false negative (FN) of 1, false positive (FP) of 3 and true negative (TP) of 47.

TABLE 4.2.1 CONFUSION MATRIX OF CONVOLUTIONAL NEURAL NETWORK

Deep Convolutional Neural Network (DCNN)			
Jute Disease		**Predicted Class**	
		Infected	**Healthy**
Actual Class	**Healthy**	49 (True Positive)	1 (False Negative)
	Infected	3 (False Positive)	47 (True Negative)

Accuracy = (TP+TN)/Actual number of subjects

Accuracy rate of our model is,

(49+47)/100 = 0.96 * 100 = 96%

Error Rate = 100 – Accuracy

= 100 –96 = 4%

Table 4.2.2 specifies the classification assessment of DCNN using evaluation metrics. DCNN has succeeded the accuracy 96% with the error rate of 4%. The sensitivity of 98% with the false negative rate of 2% and the specificity of 94% with the false positive rate of 6% have been achieved. The precision, negative predictive value and f1-score of CNN are 94%, 98% and 96% respectively. Fig. 4.2.3 plots the results of classification assessments.

TABLE 4.2.2 CLASSIFICATION PERFORMANCE ASSESMENT OF DCNN

Evaluation Metrics	Convolutional Neural Network
Accuracy	.96
Error Rate	.04
Sensitivity	.98
False Negative Rate	.02
Specificity	.94
False Positive Rate	.06
Precision	.94
Negative Predictive Value	.98
F1-Score	.96

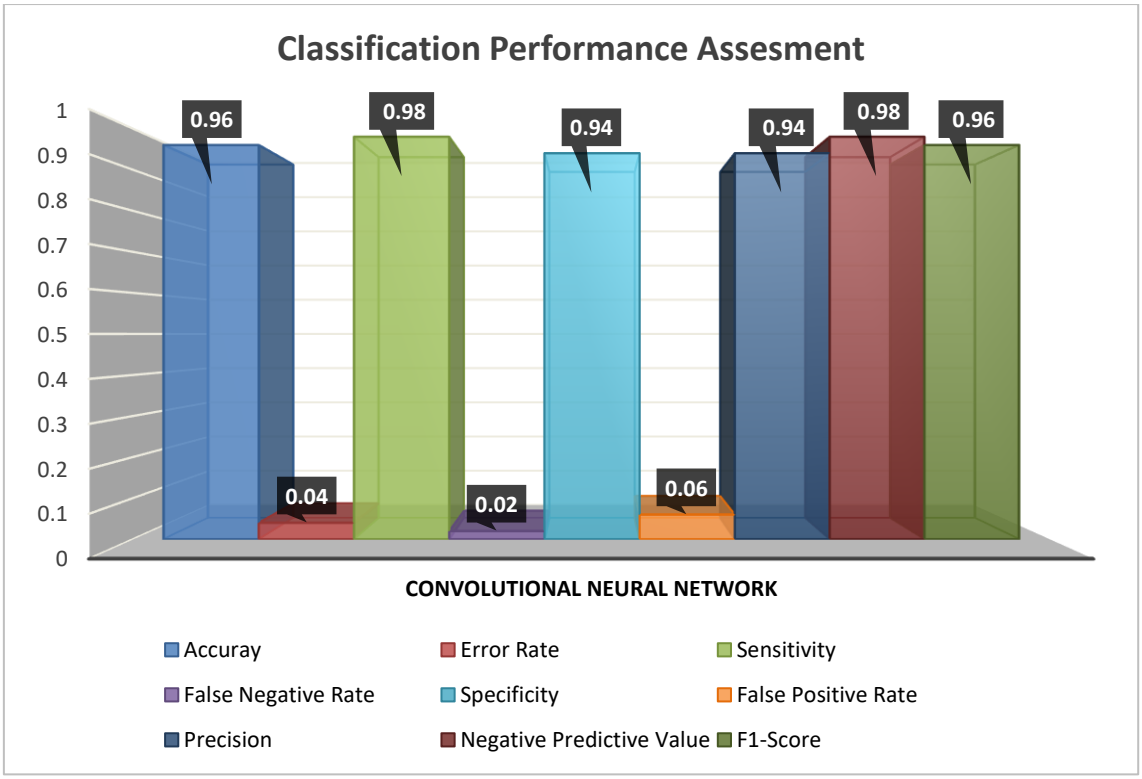

Figure 4.2.3: The Results of Classification Performance Assessments Using CNN.

From the graph in Fig. 4.2.4, it shows that the requirement of the minimum number of epochs needed for achieving the best classification accuracy to detect the infected leaf. DCNN model has improved the accuracy level from the very starting to the higher level with the increasing of epoch's and finally has reached at the accuracy 96% after 10 epochs. Fig. 4.2.5 demonstrates that the DCNN model has decreased the loss level from the higher to the lowest level with the increasing number of the epochs.

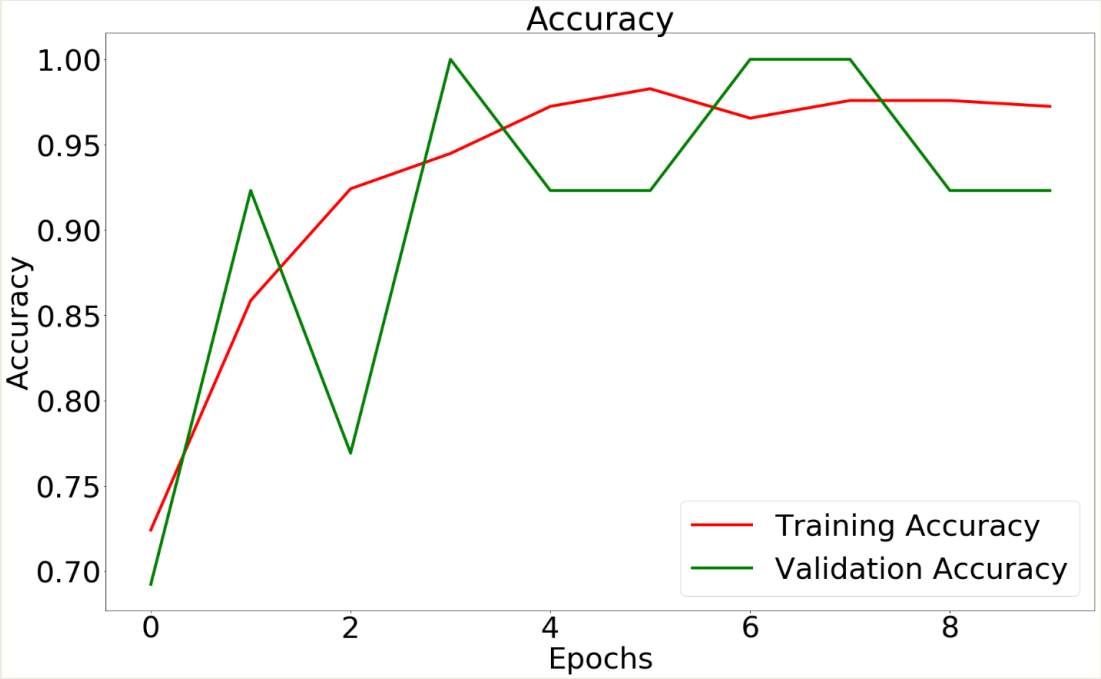

Figure 4.2.4: Training Accuracy vs Validation Accuracy.

Figure 4.2.5: Training Loss vs Validation Loss.

From the above figure 4.2.4 we see that the training accuracy is nearest to the validation accuracy. So we get it better training accuracy to when we apply this method. When training

accuracy is less than 60% that cannot be a proper solution to detecting this disease. We see that 96% training accuracy is a perfect scenario to observing this method.

On the other hand figure 4.2.5 we see that the training loss is bellow to the validation loss. When the training loss limit cross of the validation loss that is not efficient for the disease prediction. We see that our training loss is only 4% that is very efficient and that can be a better to complete.

Finally, comparing our results with other methods of detecting diseases from leaves images, it can be said that our method provides better results and better accuracy.

CHAPTER 5

CONCLUSION AND FUTURE WORK

5.1 Conclusion

Jute is a very important crop for the economy of Bangladesh. It has played a vital role in our economy in past years but not so much in the recent times as it lacks for diseases and proper direction. Without reducing diseases and proper planning we cannot improve our plant cultivation in economy of Bangladesh. For all of these we try how to detect diseases and take proper steps with give a better solution by this paper. This paper is mainly focused how to detect jute plant diseases using training and testing data by convolutional neural network (CNN) methodology and dataset. This work elaborates the possible disease of jute and a method to identify the diseases which is not attempted yet.

5.2 Future Work

In Future we have to implement a mobile application automated system on the basis of our research that detect disease of the jute leaves and give the information about this diseases. Artificial neural network (ANN) that we can easily implemented on Android phones, capable of detecting plant lesion features that has been presented The measurement outcomes in the detecting of the number of spots and their place on plant leaves results accuracy higher than 96%.We have future plan to implement our system for real life application in the rural areas so that the people of our country get benefitted from our research and it will help them in jute cultivation numerously.

In future work the color feature of the diagnosed spots will additionally be taken into consideration for immune plant disease analysis and the introduced algorithm will be implemented on smart phones and examined beneath outdoors conditions. In future we also develop both English Bangla language layout and voice navigation application system. We also would like to upgrade our system a high level where it can detect all the possible jute diseases and others that our farmers face in the cultivation period.

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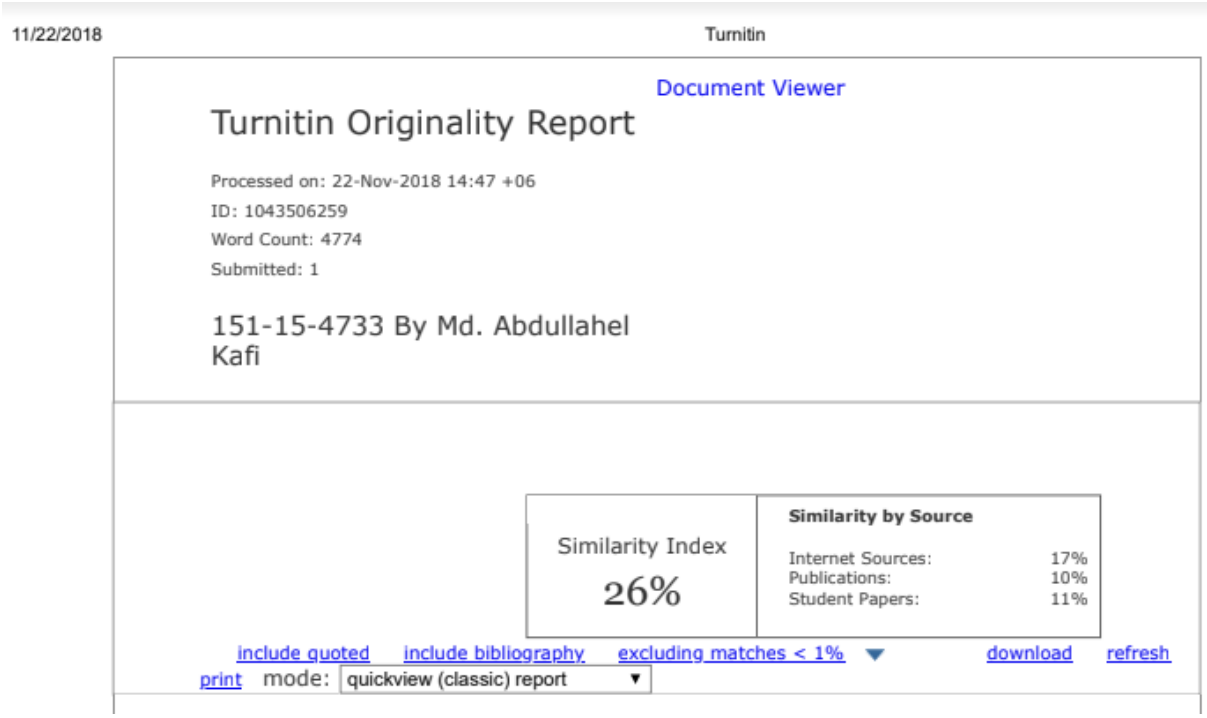

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