RICE DISEASE DETECTION BASED ON IMAGE PROCESSING TECHNIQUE

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APPROVAL

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We hereby declare that, this project has been done by us under the supervision of **Ms. Most. Hasna Hena, Senior Lecturer, Department of CSE,** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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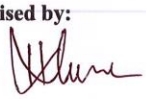

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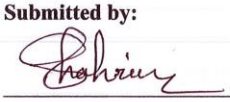

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ABSTRACT

Rice plant disease detection and monitoring is a critical issue. An accurate and timely detection of diseases in rice plants can help farmers in applying timely treatment on the plants and thereby can reduce the economic losses substantially. So, we want to develop a system on python which can detect the disease of rice plant. We studied various techniques and algorithms likes Linear Regression, Logistic Regression, CNN architectures like Resnet, AlexNet, LeeNet, VggNet and KNN regarding this issue. After many discussion and comparison between these machine learning algorithms we chose CNN architecture. We use sequential model based on CNN architecture because this architecture performs best for image classification and detection compared to other architecture or algorithm. We use a large amount of dataset for training our model and for detection. The results show that our proposed method successfully classify and find out the rice leaf diseases based on image processing techniques. Our experimental results show that we achieve 97% test accuracy with our proposed model, while other models have less than 80% accuracy.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Bangladesh is an agricultural country. Rice is the main cereal crops in our country. About 75% cultivated land are being used for rice cultivation. Rice farming plays a vital role on agricultural economy, it contributes one half of the agricultural GDP. As the population is increasing, demand of rice is also increasing and it is a major challenge to producing more crops to cover up the increasing demand. Because in last few years its production level decreases due to some unexpected disease like Brown spot, leaf blast, bacterial leaf blight etc. which causes serious damage of rice plant and also decrease the production of rice. That leads economical lose for the farmer. Some syndromes of disease are visible on affected rice plant. Some spot is emerged on the leaf of the plant. Leaf Blight, Brown spot are viewed in many shaped on the leaf. Such as the spot should be small, circular or oval shaped. Leaf blast are typically diamond shaped with brown order. From these spots we can identify the disease and can take an appropriate action. We proposed a machine learning method to identify these diseases from paddy leaf. Which will helpful for our farmer. Farmer can identify his rice disease immediately and take action. As a result, the disease cannot spread whole cultivated land and farmer can increase their production.

1.2 Motivation

Population growth rate of our country is very high but the area for rice cultivation not increasing significantly. So, the production of rice was not enough. But these low productions are being destroyed due to disease. Every year 5 to 10 percent yield losses due to a single rice disease name leaf blast. Farmers are facing loses every year. Many times, we see through the news that our farmers say that they did not produce as expected. And many times, they don't even understand the reason. And we think most of the time it is

caused by not understanding the disease. And they can't make the right decisions at the right time.

This incident touch me a lot. So, we studied how we can help them. If we can help them to find the right disease at the right time, there will be many benefits for the farmers. Now we are living in a modern digitalized world. Everywhere we can see the blessing of computer, artificial intelligence. So, we think how artificial intelligence can helps our farmer. We wanted to implement the advantages of artificial intelligence in the agricultural sector. Now we are studied in many data mining and machine learning algorithm and in future we want to work on deep learning. So, we implement data mining concept to detect the rice plant disease which will help the farmer and also our country. We have to use image processing to do the job properly. Image processing is a technology by which it can be diagnosed by looking at different image patterns. Image processing is a field where a huge amount images are trained to the machine to find different patterns. And by seeing this pattern, the machine detects the diseases.

1.3 Rational of study

The objective of data mining is to find a structure in an unstructured data. It can find out the pattern from a random dataset. It also useful for prediction, classify characteristics and so on. We are working on rice plant disease detection so we have to work on images of rice plant. As we work on images so we use convolutional neural network (CNN) algorithm. We also work on different algorithms like Resnet, AlexNet, LeeNet, VggNet but among these our CNN algorithm based sequential model perform best. Also, for predicting images and classification from images CNN based sequential model perform best. In the history of detecting of plant disease detection main motive is to detect the disease more accurate. So, we work on our model and successfully our model is more accurate than other algorithms.

1.4 Research Question

We working on the rice plant disease detection so we have study lot to find a proper algorithm which will successfully detect disease. For a better detection and classification result we need to collect huge number a rice leaf images. The more we collect data the more we can find the accuracy and the model will give more accurate detection. Collecting of leaf image data was a very challenging part maybe the highest. We were faced many kinds of question while collecting raw data and selecting algorithm.

Question we have faced:

- How can you collect raw data?
- How can you validate your data?
- Why are you chose these algorithms?
- Can you get the expected output?
- What is the benefits of using CNN algorithm?
- How this research will help the farmer?

1.5 Expected Output

We work on two types of disease brown spot and leaf blight and one healthy leaf. Our proposed model will successfully predict the healthy and unhealthy leaves from a given leaf.

1.6 Report Layout

Chapter 1:

It's all about introduction of the research. In this chapter introduction, motivation, rationale of research, research question, expected output and page layout are described.

Chapter 2:

It's all about background of research. In this section Related works, research summery, scope of the problem, challenges are described.

Chapter 3:

It' all about Methodology of the research. In this section research subject and instruction, data collection procedure, statistical analysis, implementation requirements are described.

Chapter 4:

It's all about experiment result and discussion. In this section experiment result, descriptive analysis and summery are described.

Chapter 5:

In this chapter summery, conclusion, recommendation and implementation for future study are described.

CHAPTER 2
BACKGROUND

2.1 Introduction

Before starting our research work, we are focusing on the characteristics of our selected rice plant disease. We studied over the disease of rice plant like bacterial leaf blight, brown spot. We also study above what characteristics we can say that this leaf is a healthy leaf. Bacterial leaf blight commonly affected on the leaves of the plant. Elongated lesions are seen on the leaf and the color of the lesions are basically yellow to white. Color of this disease depends on the effect of the bacteria. On the other hand, brown spot is also affected on the leaf but the shape of the disease is kind of oval and the affected area are seen as dark brown color. This background study helps us to differentiate this two-disease affected leaf from other.

2.2 Related works

There are few researches in this plant disease detection on various method and algorithm. Plant disease identification using back propagation [1]. Where at first all the image converts RGB to HSV and adjustment the image intensity. Processed image is converted to binary-level image and differentiate the spot and then extracting all the spot using back propagation. They also give the immediate solution for the next planting. But the limitation of using back propagation is once a network teaches one sets of weights, any new learning causes catastrophic forgetting.

Rice plant disease identification and detection technology through classification of microorganisms using Fuzzy Neural Network [2]. The classification is done by MATLAB function and Fuzzy neural network. For detecting the disease, it produced a sound frequency range from 20 to 120 kHz. But it is very difficult to maintain this frequency.

Main disadvantages of fuzzy network are if the model is nonlinear with a disturbance term the testing error is very large.

Unhealthy region of plant leaves and classification using texture features [3]. At First a color transformation structure is created for the input RGB images and Shape and texture features are extracted from them. They use minimum distance criterion and support vector machines (SVMs) algorithm for this work. Main disadvantages of using support vector machines that creating a color transformation structure for input RGB images is very difficult task.

Detection and Classification of plant leaf and Stem Disease based on K-means algorithm [4]. At first inputted RGB color images are converted into HIS (Hue In phase Saturation) color space. Extracting the color texture features of images. Finally, the classification is done by neural network classifier based on statistical classification. But the limitation of using k-means algorithm is that to predict the value of k and clusters of different size and different density it does not work well.

A software prototype system based on pattern recognition technique [5]. Their prototype works based on the infected rice leaf's images. Images of infected rice plant leaves are captured by digital camera. To detect the inferred part of leaf's image segmentation techniques is used. Then the classification of the infected parts done by neural network. It's only identified the infected part from an infected image but it couldn't differentiate the leaf into healthy and infected.

2.3 Research Summary

For this project we studied many research papers related to this topic and we get many information and gather many knowledge about various kind of algorithm. In Bangladesh this kind of research is very rare. So, we want to research on this topic. Different researcher uses different kind of algorithm and. In our research we used CNN algorithm's based

sequential model. We work on three types of leaves on healthy, brown spot and leaf blight. So, divide the total dataset into three, two of them are unhealthy and one is healthy dataset. Images of healthy and unhealthy leaves are taken for the proposed method and extracted healthy and unhealthy characteristics of rice plant leaves. Then these images are being processed with the proposed model and classified the rice plant leaf as either infected in disease or healthy.

2.4 Scope of the problem

In this paper we work on CNN algorithm for rice disease detection. We use CNN to recognize the pattern of leaf and extract the important information from the data and detect the disease. As we work on rice plant leaf so rice plant leaf is the main dataset of your project. Collect images of healthy and unhealthy was very challenging part. The more accurate the dataset the more our model accuracy. So, we are very much while collecting data. We collecting raw data from various rice field and agriculture institute. So, collecting accurate raw data is a scope of the problem in this project.

There is some automated system already run which detect the rice disease but their accuracy is not good. There are many prediction models but their classification and detection in not correct. So, we studied to run a model which will more accurate, good interface and detect the disease successfully. So, finding an algorithm is also a scope of the problem for this project.

2.5 Challenges

Image data set is our main assets. Collecting huge number of data was very much challenging part. We have to collect not only rice leaf image but also accurate disease leaves. So, we have to very aware when we collecting data. We have to also aware about the resolution and size of the images. Selecting best algorithm also a challenging part. We studied various algorithm. After many tests we select the best algorithm for our research. So, data collection and selecting algorithm was very macho challenging to this research.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

In machine learning deep learning is now most popular things. It creates its popularity because of its high-level performance over different types of data. For classifying image in deep learning building convolutional neural network (CNN) is a great way. To build the convolutional neural network (CNN) keras library makes it simply [11].

By the help of pixels, computer see the images. Convolutional neural network (CNN) identify the images by these pixels. We are working on images where three different types of image should be detected. By the help of keras library we build our model layer by layer. The model is basically a classification model because it classifies the image whether it affected or not and if affected then predict that which disease affected this.

3.2 Research Subject and Instruments

We are working rice plant disease detection using machine learning. We use python as machine learning language in anaconda command prompt. We use convolutional neural network algorithm, confusion matrix and learning rate in it. We apply sequential model and then find the prediction. We use confusion matrix to determine how accurate and validate our prediction is. We also use learning rate graph to see the validation accuracy and loss function in a pictorial view while training the dataset. We use drop box to store our data and access faster. We train our model on Google colab to use external GPU.

3.3 Data collection procedure

In this research we use rice leaves images as our main dataset. To complete this project, we collect raw data.

3.3.1 Data collection

Data is the main assets of this project. As we working with images so we have to collect a huge number of images. Image is the main dataset of this model. So, we need to aware about the image sizes, resolution, quality while collecting images and also about the syndrome of the disease leaves. We collected images from Kaggle, Dataquest and we captured some images manually. Collected almost 3000 images two of them are disease (Brown Spot and Leaf blight) and another one is healthy leaf.

3.4 Statistical Analysis

We collected thousands of images but all these weren't useful for us. Some pictures resolution is very poor, some are hardly classified as healthy and unhealthy. So, we selected 300 images for brown spot, 300 images for healthy and 300 images for leaf blight for the training purposes. Similarly, we select 110 images per folder for the validation. The dataset we are using for this research is not relatively clean. That's why we have to perform data processing to get ready our data for modeling. For data processing we have to maintain following steps:

3.4.1 Image Acquisition

Image acquisition is defined as action of restoring image from some hardware-based sources for processing. It is the first step because without an image no processing is possible. Digital camera is used here to digital acquisition. Digital camera is attached with a magnifying lens which can catches little spot pictures from rice leaves. Then these pictures attached to pc for further testing. These captured pictures resolution depends on the digital camera and magnifying lens.

3.4.2 Image Enhancement

For improving the quality and information content of data image enhancement is must needed. Contrast enhancement, spatial filtering, density slicing is the part of image enhancement. Contrast enhancement and spatial filtering improves the linear features of

the picture. Density slicing converts the continuous gray tone range into a series of density intervals marked by a separate color or symbol to represent different features. Before image segmentation image enhancement is performed. It is used to reduce the noise and contrast adjustment to improve the quality.

3.4.3 Image Segmentation

Image segmentation is a process where an image partitioned into multiple segment or set of pixels. Simplify the image is the main goal of using the segmentation. After segmenting the image, it is lot easier to analyze the image. For the smooth analyzing make the images more meaningful we segment our image dataset. It assigns the label into every pixels of image. Fundamental objective is to extract the important information from the rice plant leaf images.

3.5 Implementation Requirements

3.5.1 Neural Network

Artificial intelligence is a bridge between the machine and human. The advancement of the computer vision has been improved due to one algorithm which is CNN. CNN is a supervised learning architecture. The key operation of CNN is convolutional filter. Convolutional filter identifies the relationship between raw images. It is used for increasing the generalization ability of CNN. By using activation function CNN computes future maps [14] .The function was:

$$y_j^l = f(z_j^l) \qquad (1)$$

Where, y_j^l is the future map and $f(z_j^l)$ is the activation function.

Datasets are stored in 2-dimentional convolution operation in convolutional neural network (CNN) [14].

$$O = \frac{(W-F+2P)}{(S+1)} \qquad (2)$$

Where:

O = output height/length

W = input height/length

K = filter size

P = padding

S = stride.

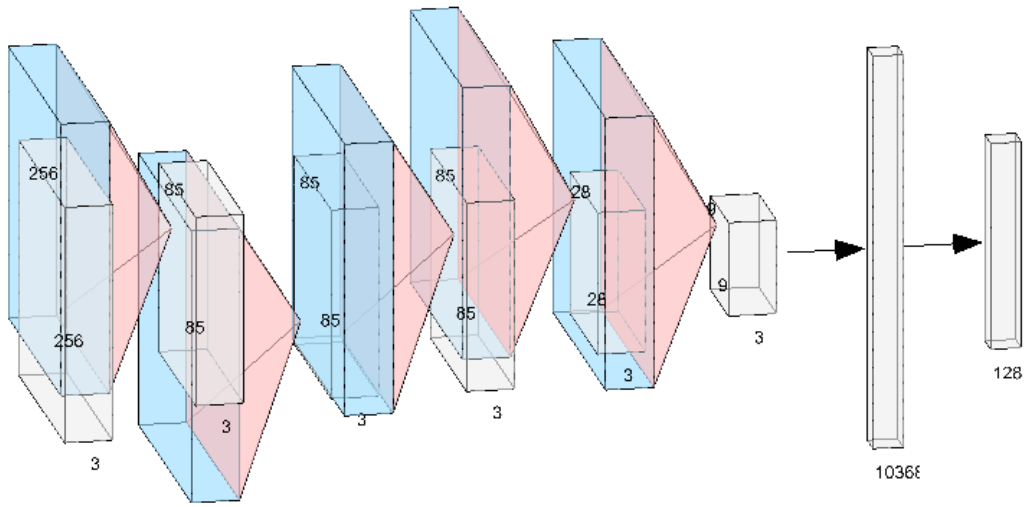

Figure 1: Convolutional Neural Network (CNN)

Figure1 shows the basic structure of CNN for our model using the layer, padding, height, width, dense we used on our model [10].

3.5.2 Building the model

By using convolutional Neural Network (CNN) algorithm we build a model named sequential [13]. Sequential model was build up using keras [12]. Keras helps to build this model as layer by layer. For adding layers we using add () function. We using convolutional2D layer to deal with our input images to seen as 2-dimensional matrices and for output images we use dense layer. The kernel size was 3x3 as a filter matrix. ReLU or Rectified Linear Activation was used as an activation function for this model [15].

$$Y = \max(0, x) \qquad (3)$$

Images must be inputted in this model. We fixed the input size of the images which is (256,256). That means height and weight of the images should be 256. Between the convolutional2D layer and dense layer there was a flatten layer which was serves as a connection between them. After adding SoftMax as an activation the model will then make its prediction based on which option has the highest probability [17]. SoftMax function equation is given below:

$$P(y = j|x) = \frac{e^{X^T W^l}}{\sum_{k=1}^{k} e^{X^T W^l}} \qquad (4)$$

Here, X^T W denotes the inner product of X and W.

Pictorial view of our sequential model is given in the figure2 [10].

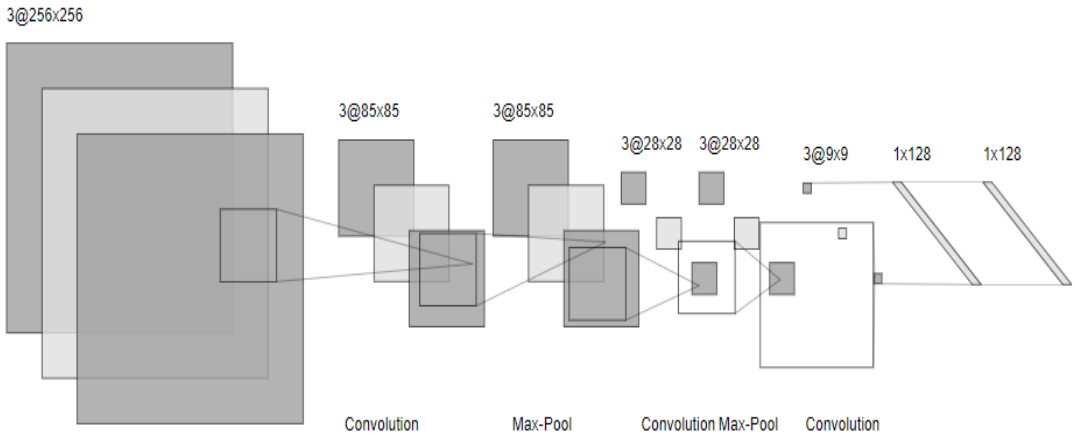

Figure 2: Sequential Model

3.5.3 Compiling the model

Three parameter optimizer, loss and metrics used for compiling the model. To controls the learning rate optimizer was used. “adam” was used as an optimizer. It actually a good optimizer for adjusting the learning rate throughout training. For our loss function we will use ‘categorical cross entropy’. To make things even easier to interpret, we will use the ‘accuracy’ metric to see the accuracy score on the validation set when we train the model.

3.5.4 Training the model

To train, we use ‘fit ()’ function on our model with the following parameters: training_generator, validation_generator, and the number of epochs. We using our testing dataset as our validation data. In the fit function we set the epochs number which will cycle the model through the data. To improve our model, we must increase the number of epoch up to a certain point.

CHAPTER 4
EXPERIMENT RESULT AND DISCUSSION

4.1 Introduction

Rice disease prediction is a state which describing about the rice plant is healthy or unhealthy. In this chapter the result of the project is presented and discussed with the aim of the study which was to determine the rice plant disease. In this project we use CNN architecture and try various algorithm like AlexNet, LeeNet, VggNet, ResNet to see the difference. At the end we find our expected outcome what we want to find out in this project. Here we will show what result we find and also briefly discuss about the result. For better prediction and accuracy, we will work on this project in future.

4.2 Experimental Result

4.2.1 Confusion matrix:

In the field of machine learning error matrix is another name of confusion matrix and it is a visualization form of the performance of an algorithm. We use confusion matrix to see how our model work. We see that the confusion matrix shows the highest value in diagonally so we can say that our model performs well. We use sequential model, AlexNet, LeeNet, VggNet for finding the best confusion matrix. Among these sequential model gives us highest diagonal value. All the confusion matrix of those models and algorithm are given below:

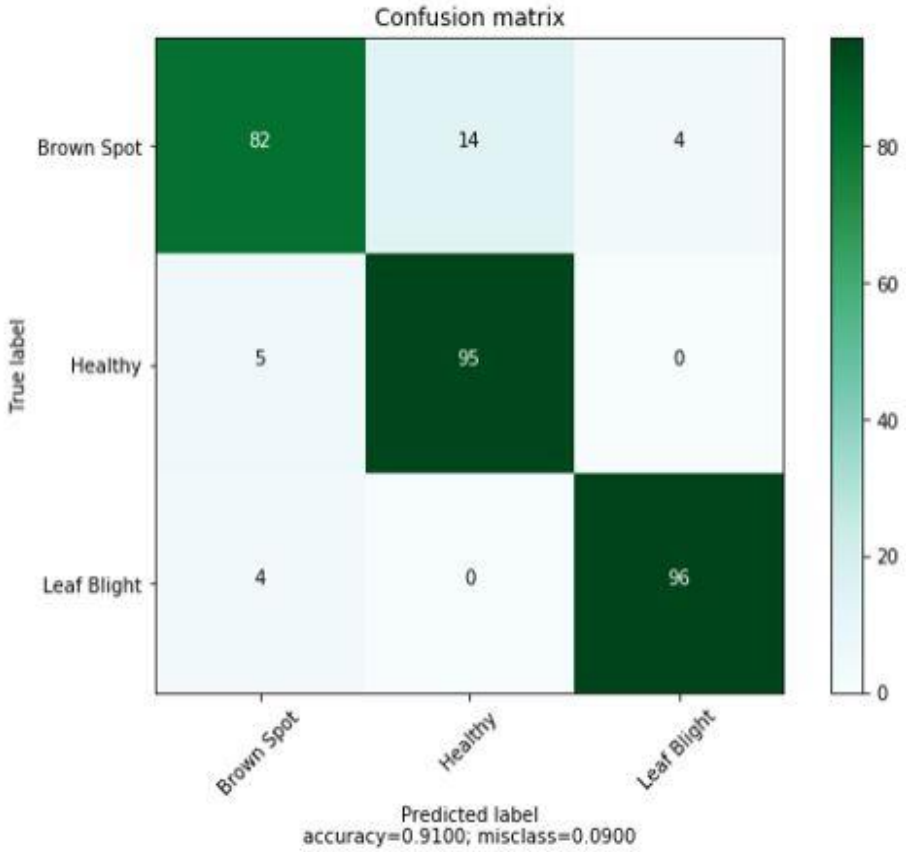

Figure 3: Confusion matrix (Sequential model)

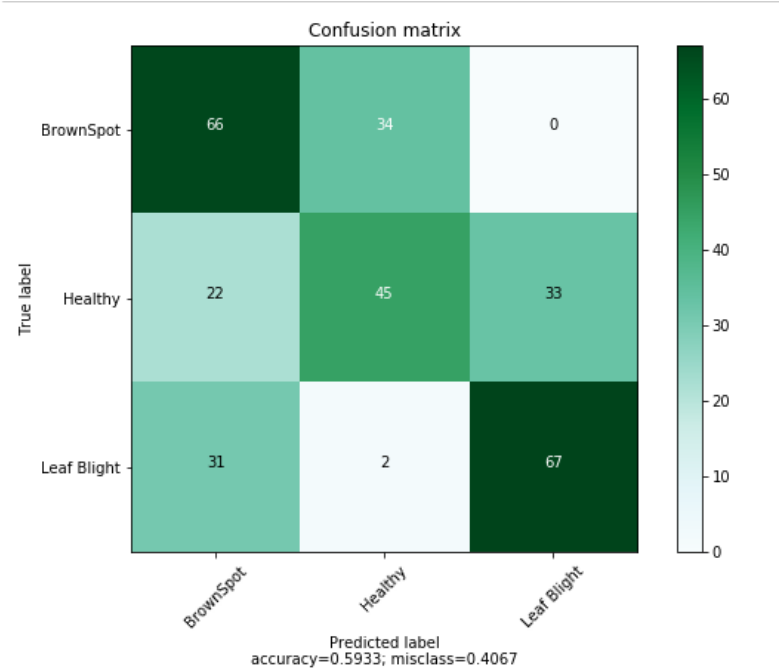

Figure 4: Confusion matrix (LeeNet)

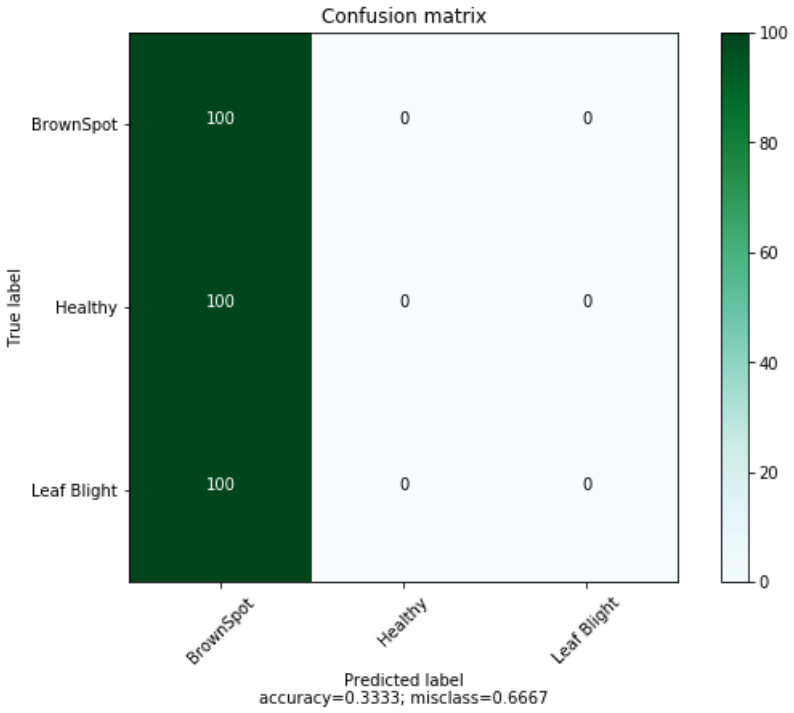

Figure 5: Confusion matrix (AlexNet)

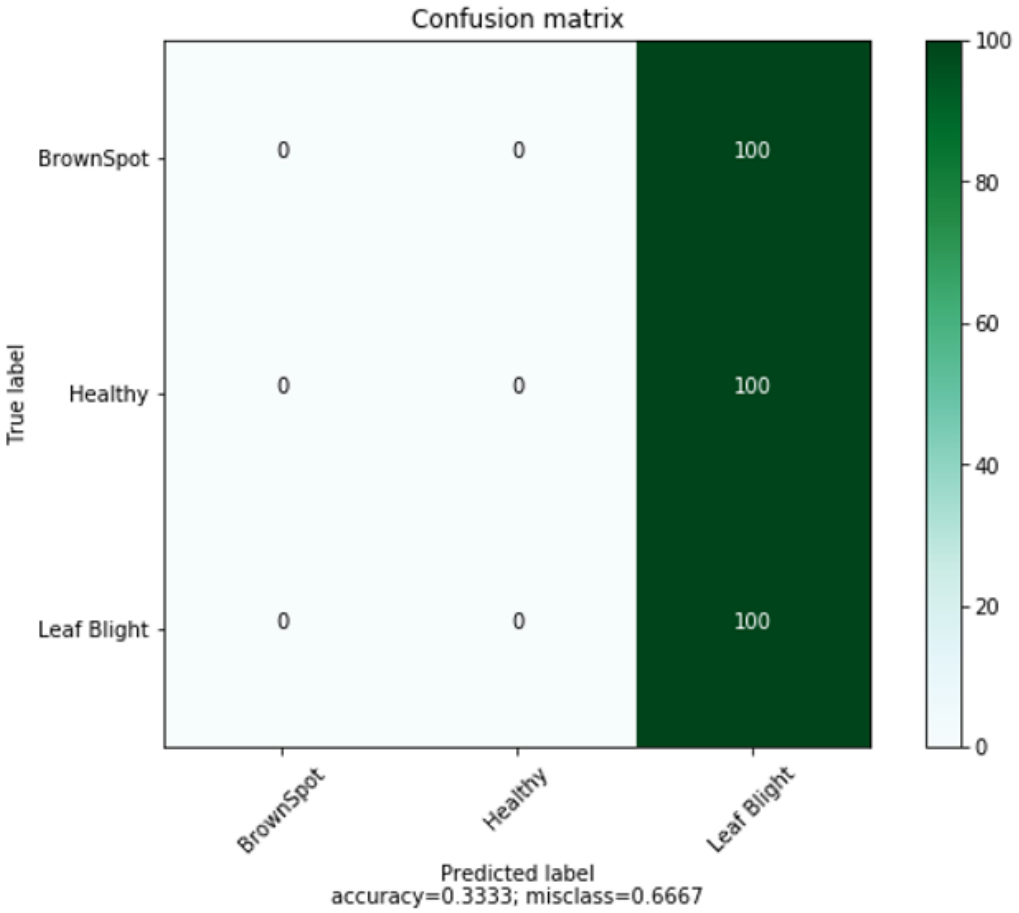

Figure 6: Confusion matrix (VggNet)

4.2.2 Learning Rate:

In machine learning the learning rate or step size is a hyper parameter which determines to what extent newly acquired information overrides old information. After experimentation we also found our learning plot. We use sequential model, AlexNet, LeeNet, VggNet for finding the best learning rate. Among these sequential model gives most smooth learning rate. All the learning rate of those models and algorithm are given below:

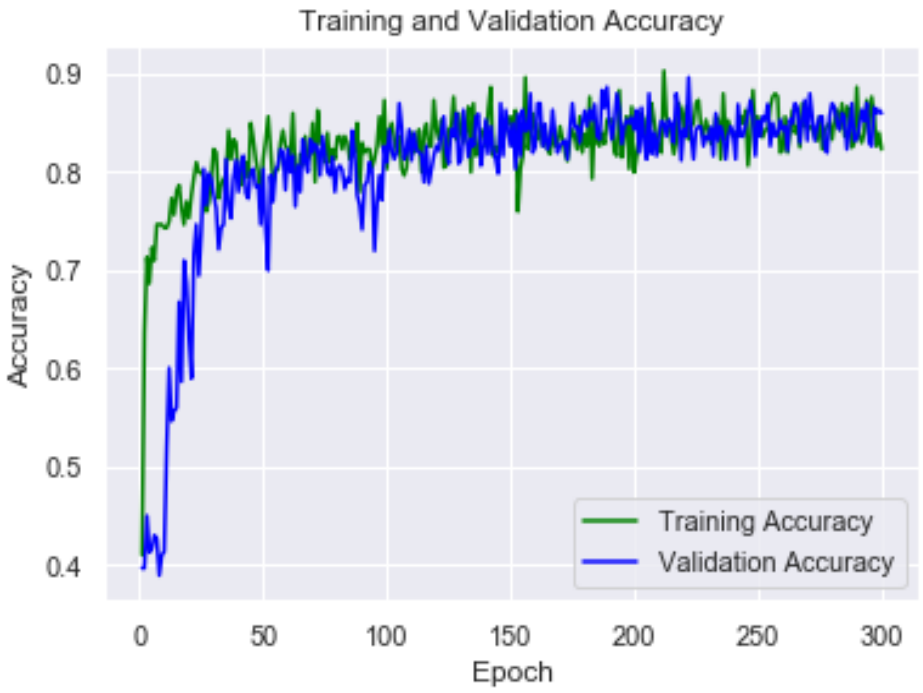

Figure 7: Accuracy graph (Sequential)

Figure 8: Loss graph (Sequential)

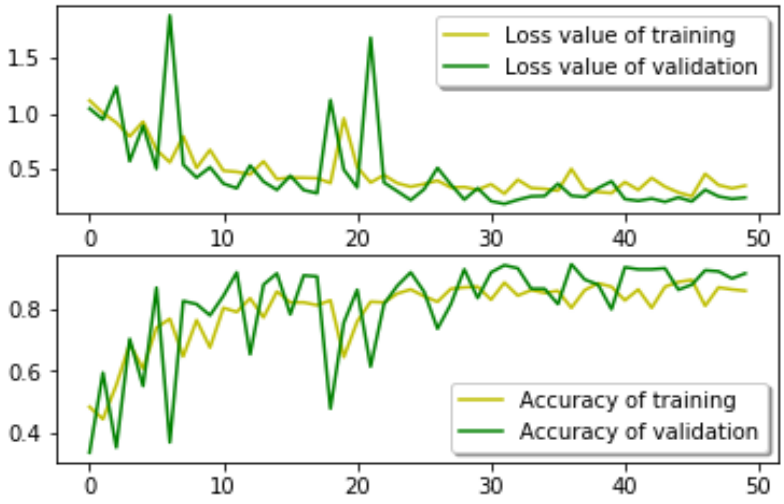

Figure 9: Accuracy & Loss graph (LeeNet)

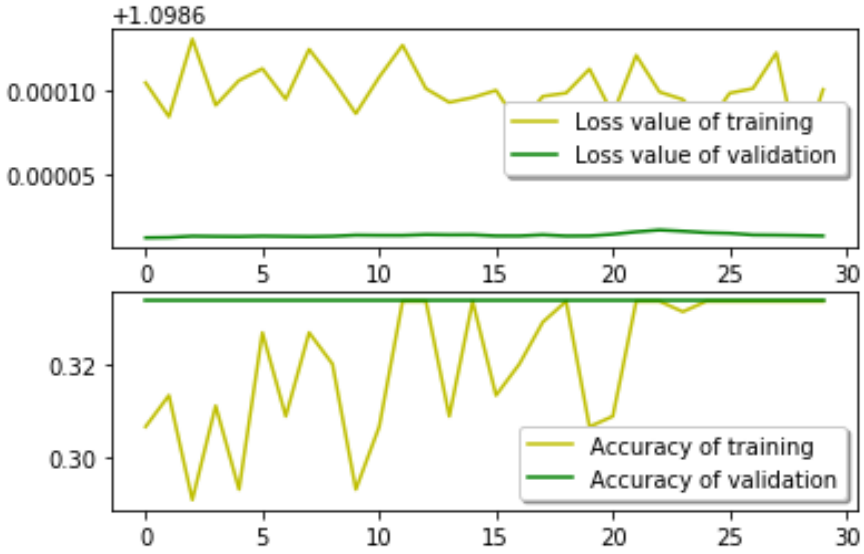

Figure 10: Accuracy & Loss graph (AlexNet)

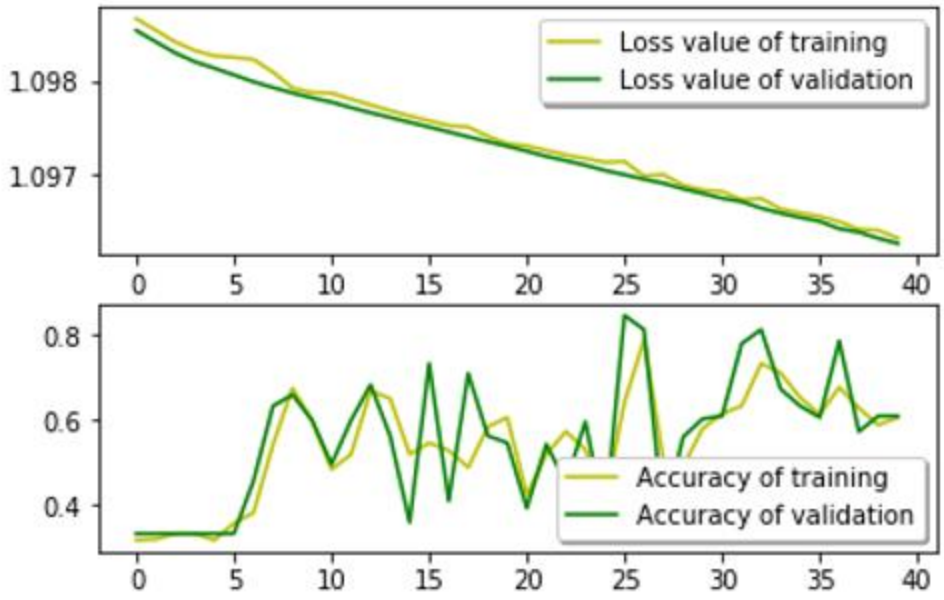

Figure 11: Accuracy & Loss graph (VggNet)

4.2.3 Prediction:

Figure 12: Healthy leaf

Figure 13: Brown Spot affected leaf

Figure 14: Leaf Blight affected leaf

4.3 Descriptive analysis

We use confusion matrix to see how our model work. Confusion matrix is used to measure the performance of classification model in a table for the test dataset and also known the true value. It visually shows the performance of an algorithm. It counts the values of correct and incorrect predictions [18]. Accuracy or classification rate formula are given below:

$$Accuracy = \frac{(TP+TN)}{(TP+TN+FN+FP)} \qquad (5)$$

We also find the error of the model. Error comes from this equation:

$$Error = 1 - Accuracy \qquad (6)$$

Then we use learning graph to show the accuracy graph and loss graph while data in training and validating. We can see at the beginning curve is very high but at the time passes it flatten and gives almost straight line. So that at the very beginning validation loss

is very high and accuracy is very low but after time being validation loss reduced and increased the accuracy. When we input a random image if it matches with brown spot image than it shows that the prediction image is brown spot. When we input a random image if it matches with leaf blight image than it shows that the prediction image is leaf blight. When we input a random image if it matches with healthy image than it shows that the prediction image is healthy.

4.4 Summery

In 19th century people are trying to detect rice disease manually but they face many problems because detect disease manually is very much difficult and time-consuming task. So we want to develop a system which can solve this problem. At initial stage we work on only two types of disease and a healthy leaf. Further we will increase our disease. We also studied another four model Resnet, LeeNet, AlexNet and VggNet. Resnet model gives us good accuracy and correct prediction but it's very heavy model. In training and testing is takes too many times and its model file is very large so it's not efficient to use. LeeNet and VggNet couldn't give good accuracy because they are useful for text. AlexNet also bad perform it also used for text. So, among all of these our sequential model performs best so we select sequential model. We also wanted to apply this project in android so that it will more efficient and useful to all the user. There is some limitation on our project as I said earlier, we only work on only two types of disease so if we inputted different disease image it shows wrong prediction, if the image quality is not good it won't perform. So, despite these limitations our model is looks good. So, we are working on our limitation. Further if we notify any problem on it we will check that and update that from our position.

CHAPTER 5
SUMMARY, CONCLUSION, RECOMMENDATION AND IMPLICATION FOR FUTURE RESEARCH

5.1 Summary of the Study

Any prediction can't give the accurate result. There always some wrong prediction and limitation. But we have tried our best to get the more accurate prediction from our research. CNN architecture is used to classify the leaf as healthy or unhealthy. We use sequential model for training and validating our dataset. Then in the prediction part we input an image and then it predicts whatever the image is brown spot, healthy or leaf blight. We use confusion matrix and learning rate to show how well and model.

5.2 Conclusions

For real time rice disease detection, we have proposed convolutional neural network (CNN) based Classifier model named as sequential. For achieving desired accuracy, we have also introduced two stage training. We have conducted a comprehensive study on various kinds of rice disease incorporating nine classes of rice diseases. We have collected a lot of images of rice plants from the rice field. We have applied different types of algorithm based on the CNN architecture for finding the best result. We have successfully been able to classify the disease affected plant and healthy plant by our sequential model. This model also help farmer to decision making while farming. It can give more accurate result when the dataset is larger. Before processing the datasets can valuable in the prediction and unprocessed data can also affect the efficiency of the model. Our validation accuracy and test accuracy are found to be very high, because our training, validation and test set are well classified. We plan to work with memory efficient non-sequential CNN models in order to achieve higher accuracy in plant disease classification in future.

5.3 Recommendations

Where we done the prediction using only two types of disease but rice is affected in various kind of diseases. So, for better and dependable prediction we must add more image data of more different types of disease. It will more efficient to use if you implement this on android system. Then one easily takes a picture using smart phone and detect the disease. So, in future we will work on this.

5.4 implementation for further study

Prediction for rice disease detection is not a say task. From the output of the research we will make a system for predicting the leaf as healthy or unhealthy. It's not only software-based project it needs hardware. In future we will work with software and hardware both to get the better and real time result.

APPENDIX

Appendix A: Research Reflection

We started our research from January 2019 to implement this rice disease detection. Our main motive of this research is to find a way to detect rice disease using artificial intelligence. It's very essential to keep the disease and healthy images to dataset and predict efficiently. This research will help the farmer to detect the disease easily and more accurately. After a long journey and hard work, we reach our goal.

Appendix B: Related Issues

Before working on this research, we have to read many paper and journal. Disease detection is very challenging work and need huge number of image data. We have to do field work to collect huge number of image data. We implement our project on Jupyter notebook using python language.

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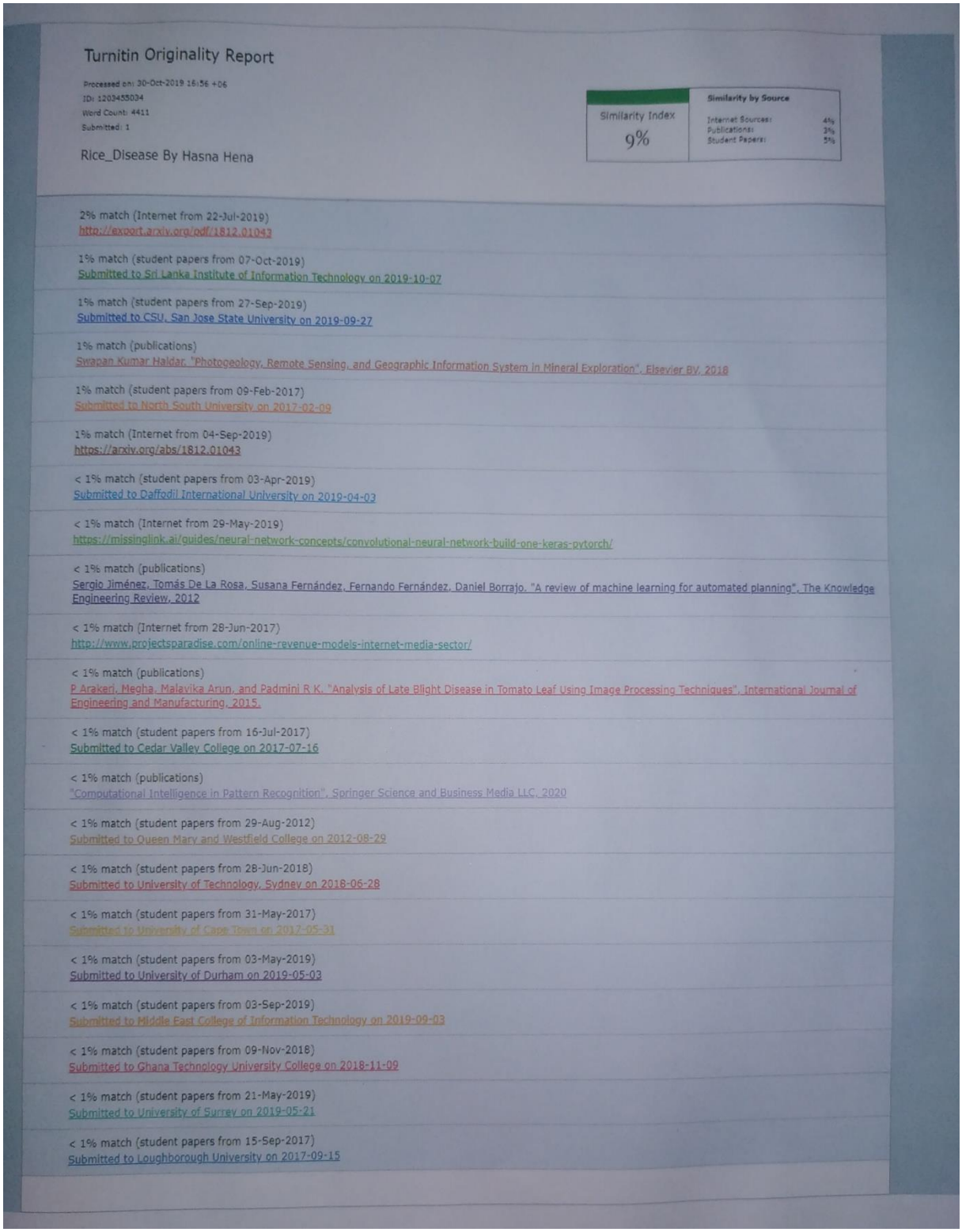

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