Farmabot: An Approach for Detecting Rice Leaf Disease Using Convolutional Neural Network

BY

Sajib Hossain
ID: 161-15-7504

&

Md. Mahabub Hasan
ID: 131-15-2493

This Report Presented in Partial Fulfillment of the Requirements for

The Degree of Bachelor of Science in Computer Science and Engineering

Supervised By

Shaon Bhatta Shuvo

Senior Lecturer

Department of CSE

Daffodil International University

DAFFODIL INTERNATIONAL UNIVERSITY

DHAKA, BANGLADESH

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APPROVAL

This Project/internship titled **"An Approach for Detecting Rice Leaf Disease Using Convolutional Neural Network"**, submitted by Sajib Hossain ID No: 161-15-7504, Mahabub Hasan, ID No: 131-15-2493 to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 5 December 2019.

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Department of Computer Science and Engineering
Faculty of Science & Information Technology
Daffodil International University

Dr. Mohammad Shorif Uddin — **External Examiner**
Professor
Department of Computer Science and Engineering
Jahangirnagar University

DECLARATION

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

Supervised by:

Shaon Bhatta Shuvo
Assistant Professor
Department of CSE
Daffodil International University

Submitted by:

Sajib

Sajib Hossain
ID: 161-15-7504
Department of CSE
Daffodil International University

Mahbub

Md. Mahabub Hasan
ID: 131-15-2493
Department of CSE
Daffodil International University

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Finally, we must acknowledge with due respect the constant support and passion of our parents.

ABSTRACT

Our Agriculture is mainly based on rice. Almost 75% of our agricultural land is covered by rice field. 28% of GPD comes from rice. Rice production is being increased every year. But due to leaf disease our farmers are losing huge amount of profit. So, we have decided to find an easy solution where farmers can detect the diseases and get proper help. We have collected three types of diseases demo and build a dataset. Farmers will get help via Facebook messenger and our dedicated android app. They will simply capture the photo and received help.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Computer Vision is a very important term in the field of ICT in this modern age. Application of Computer Vision will help to develop our agricultural sector. To give a proper solution it's necessary to find out the problems and related requirements in this field. It's also necessary to know the government policy or regulations and software industry requirements along with the course methodologies to implement AI in the agricultural sector. Go through a short survey on farmers and developers to find out the problems related to agriculture and AI that are the barriers to detect rice leaf diseases.

Rice is the staple food of Bengali, Indian and other Asian countries. Nine out of ten Asian people. It is the most important food of developing countries. In Africa, rice is going to be the staple food soon. It is called the global staple food. There's lots of food made of rice too. But the farmers who made this possible are mainly illiterate. They don't have access to high end technology and information. So, their plants suffer the most. On the other side Every year lots of productive agricultural land is lost through non-agricultural uses like housing, roads and other development program. Riverbank erosion, global warming, and climate change affect people who lose everything annually and making them virtually beggars. The most important note that the outbreak of diseases and pests has recently become very sharp due to the unfavorable effects of climate change, especially the rise in temperature. Agriculture is an ancient and developing day by day but due to adverse effects of climate change, the disease becomes very severe now. There are twenty-one common rice diseases in Bangladesh. Our project is capable of giving results of three diseases out of twenty-one diseases.

Nowadays lots of people are using smartphones, though they haven't passed school level education, they know how to use messenger. They can chat with friends easily. We have taken this chance to implement our project. We have released a chatbot which will show take image as input and show result in Bengali. There is also an independent android app which will allow user to take image and see the result instantly. It will not require an internet connection to work.

1.2 Motivation

In recent years, Bangladesh is going through an ICT revolution. The development of Bangladesh in the field of information and communication technology is remarkable. But the application of ICT in the field of agriculture is very limited. Moreover, Bangladesh is an agricultural country and most of our economic support of this country comes from agriculture. However, due to proper steps farmers cannot enjoy the facilities of ICT in this field. Use of digital devices and update technology is still absent in the field of agriculture. We need to engage more ICT application in this field if we want to develop our agricultural site along with the ICT. Traditional methods are very complicated to detect the problems and find out the possible solutions in this sector. Besides most of our farmers are not educated and that is why it is not very easy to know about the new diseases and insects through blogs and books. AI will help them to find out the leaf with disease easily. This thesis focuses on the current status of agriculture in Bangladesh and will try to make a revolutionary change in the field of agriculture using AI and image processing. Which will help the farmers to detect disease easily and perfectly.

1.3 Objective

The world is changing meticulously now-a-days. This change is a mixture of both good and bad. Depends on how someone acting with it. The technological change is very effective among all this. We took some positive help of this changing technology to make something good and help our farmers. They don't know which is the best way to prevent diseases. They follow the traditional ways, which is not always the best way to get rid of those diseases.

Farmabot, works both on android and iOS through messenger Chabot. We also have an android application which will take input from user, an image obviously to detect leaf diseases. They can also chat with our AI to get help.

Our chatbot will not only detect the diseases but also provide solutions in Bengali language.

The person, who will use our app will see an easy interface to interact with.

1.4 Expected Outcome

- The chatbot or app will detect the diseases perfectly.
- The result will be shown in Bengali to user.
- User can change the language if he/she wants.
- Give them proper solution.
- Chat with experts.

1.5 Report Layout

- The examination of the idea of standards, hypotheses and strategies enlisted by jurisdiction.
- The vital investigation of idea has been placed inside the order.

CHAPTER 2

BACKGROUND

2.1 Introduction

In Bangladesh there are no similar work was done which can detect rice leaf diseases perfectly. So the background is the current situation of agriculture and the use of AI in agricultural sector of Bangladesh.

2.2 Related Works

Image processing using CNN, for detection the visual diseases is quite powerful for recognize the image. Researchers are trying to detect the pest & disease using image processing and different algorithm where a few researchers got success in this type of work. We have found some research.

Arun Sahayadhas et.al [1] proposed a system to classify rice diseases using image processing and Bayesian network. Brown spot and Bacterial Leaf Blight is the subject of this research. They have collected some samples for both diseases. Based on color and histogram feature extraction has been used. In this research color shape texture and histogram is used to implement the system. MATLAB has been used to RGB color projection value extraction. The Bayesian network has been used for classifying the images.

Mangla, Neha & Raj, Priyanka & Hegde, Soumya. et.al [2] used Otsu's method to detect rice leaf diseases. They converted RGB images to monochrome to get a better result.

Reinald Adrian D. L. Pugoy and Vladimir Y. Mariano et al. (2018) [3] used K-means clustering algorithm to group related images And uses to detect leaf diseases using images

M.N. Abu Bakar, A.H. Abdullah, N. Abdul Rahim, H. Yazid, S.N. Misman, M.J. Masnan et al. [4] has researched on Rice Leaf Blast (RLB) Disease. They have resized, enhanced and background subtract to make the images better for analysis. By using monochrome images and border tracing algorithm they have got a good result.

Jia Shijie et al. [5] made an automatic system that can identify tomato pest and diseases depending on the surface of the leaf. They used VGG16 algorithm and transfer learning to construct the CNN model to detect the pest. They used the original VGG16 model by the help of fine-tuning algorithm to classify the model.

Trupti S. Bodhe et al. [6] mentioned a system for Color image segmentation using entropy for image segmentation to calculate each color space component. Different color space is used, like YUV, HSV, RGB, YIQ, HSI color space for appropriate transform operations. They cluster pixels into salient image regions.

Nguyen Tuan Nam et al. (2018) [7] select three implementation method using CNN. In this, all implementation is based on CNN. First, to achieve classification purposes put together an adaptive threshold function for localizing objects with CNN.
The research can give a spanking framework to support the research. Here all the literature survey paper is talking about pest or diseases identification and several researchers made a variant solution to recognize the diseases. The main goal of this project is to find out the diseases and provide a piece of better information to the farmer and somehow here all the literature survey paper is related to the goal of this paper.

2.3 Bangladesh Perspective:

In Bangladesh's perspective the great threat of increasing crop productivity is a huge population that has become a vulnerable threat for the crop. The majority of the farm that constitutes by small and marginal farmers who are financially poor cannot afford high-level technology which can detect and can give a solution to this problem. In our country, our government always try to help our farmer but they don't have a good knowledge of technology. Some farmers are unskilled about diseases detection and cannot use exact medicine for these diseases. Some are well known about diseases but don't know the proper solution to it. Due to climate change impacts and lack of modern technology incidence of diseases has lately become severe problems. Due to a lack of enough knowledge about technology farmers have no interest in technology. There is another problem is they are not familiar with technology.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Using Convolutional Neural Network with 3 different classes of images this work achieved 94.62% accuracy.

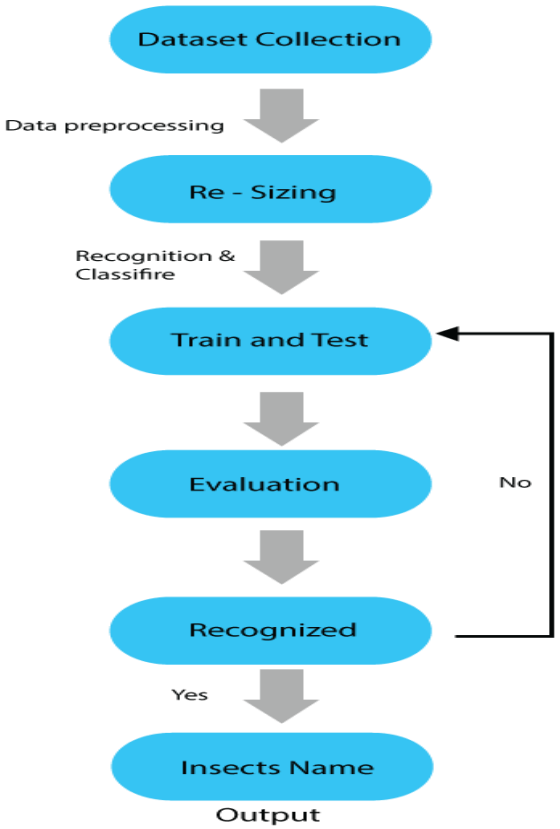


Figure 3.1.1. Steps of Data Collecting and Processing

3.2 Experiment Data Set:

This dataset consists of two hundred forty square images and there are three categories. Most of the images of this dataset were captured from fields and trees and others are downloaded from the web. The grievous things were that collection of all the data manually from field was difficult

because of seasonal problem. This dataset is created to perform an image recognition project. In this dataset there are around 300 images with many classes.

Figure 3.2.1 Collected Dataset

3.2.1 Data Pre-Processing:

All of the data which has been collected from Google and some from manually from the field by smartphone where the images were not in the same size and resolution. When we were trying to train and test the dataset it was very difficult. This version of the dataset containing a fixed resolution of pictures. According to our project requirements, we have converted all images into a square dimension. We made the images to a fixed resolution of 300 × 300 that is the down-sampled of the image. First, we cropped all the images at a variable square dimension for reducing unnecessary objects from the images. Then we scaled it into the required dimension form the cropped images. We use Adobe Photoshop to preprocess all the images. In addition, we trained our model on the RGB color mode.

3.2.2 Architecture of the Model:

The model which is designed to identify the diseases or spot from anywhere and there are four convolution layers in the model and the model has two fully connected layers. A fully connected layer is included with batch normalization, several dense and dropout which can help to utilize the model. First convolution layer which is considered as input layer and its kernel size is 3 with input shape 32x32 of RGB color mode and the filter size is 32. The layer using ReLU (1) activation with strides (1) and have the same padding property. The ReLU function when get input positive value, it returns that value back and similarly when getting input negative value it returns 0.

$$f(x)=\max(0, x) \quad (1)$$

The convolution layer 1 output goes to the input of the first max-pooling layer. To make sub-regions binned max-pooling reducing the number of parameters and here the max-pooling layer containing pool size 2 with strides 2. In the second layer, the filter size is 64 with kernel size is 3 and the stride is 1. In this layer has batch normalization to regularize the convolutional network which is vanishing gradient during training and can make better performance and minimize the training time. Here batch normalization is using to makes the learning process quicker and can use the higher learning rate. The result of convolution layer 2 is connected with the next pooling layer. The layer has also same pool size 2 with strides 2.

Layer 3 holds 128 filter size but the other property of kernel size, strides and batch normalization same as like as layer 2. Layer 3 gives output and the output is associated with the third pooling layer and the pool size, strides is 2. Layer 4 has filter size 256 where it is containing the same feature as like as layer 3. But here in this layer, 25% dropout used to make the model more stable during training and this can be too strong of regularized.

After all this 4 layer there are two dense layers which represent a matrix-vector multiplication. In the first dense layer have 256 concealed units and drop out is 25% with activation value. To tackle the over fitting dropout technique is used here. In the second dense layer, the dense is 6 without drop out to normalize the model and the activation is sigmoid. This how the model is built.
After adding all this layer in the model the result is becoming smooth and noisy free and then adding two fully connected dense layer for making a better performance of the classification task where there are also batch normalization and drop out the property. Then by applying a sigmoid to it, it will convert the data to probabilities for each class. A sigmoid function-

$$(z)=1/(1+e-z) \quad (2)$$

The binary cross-entropy is helped to define the loss which acts as a loss function for binary classification problems. After that, the optimizer, which will help to perform gradient descent and the metrics set accuracy since this is a classification problem.

The figure 3.2.2.1 which is presenting the architecture of the summary of the model: -

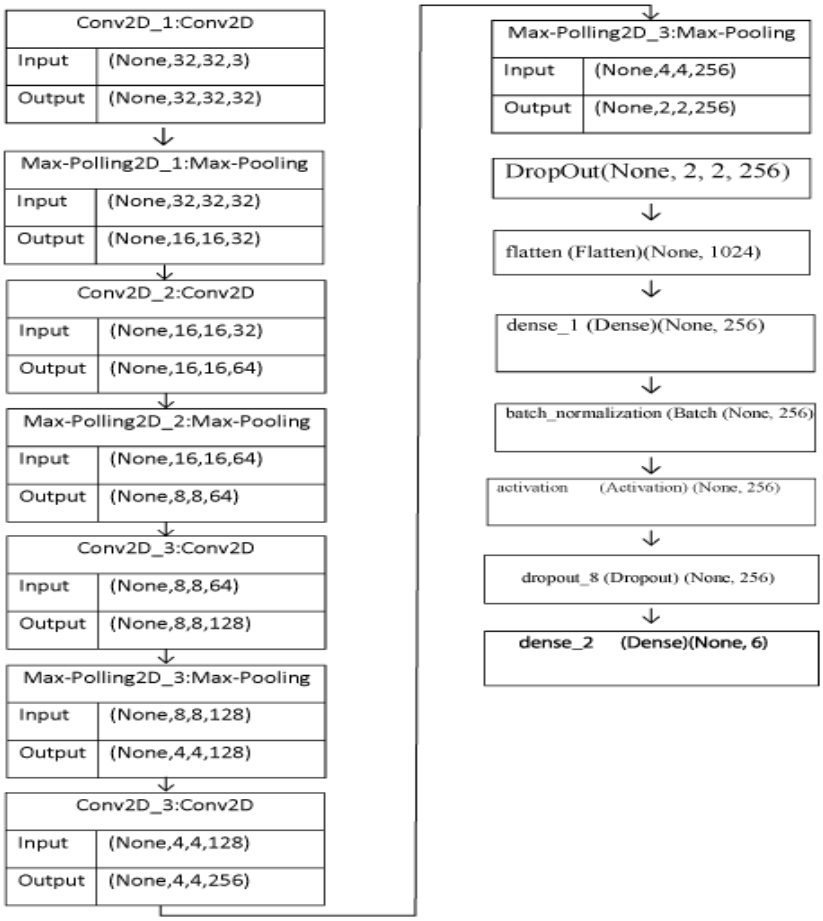


Figure 3.2.2 Representation of model summary

3.2.3 Learning rate and Optimizer of the model:

Based on training data Adam Optimizer 0.001 update network weights and make result faster in the initial learning level. In their technical words of the paper they updated the network weights by passing from one iteration to the next iteration. Weights are updated according to k (3), where k is the iteration index.

$$w_{lij}(k+l) = w_{lij}(k) - \mu g_{lij}(k) \qquad l= 1,2,\ldots.L \qquad (3)$$

Learning rate performs best for moth 1x size and 10x model size the same, which means it does not depend on model size. Selecting learning rate is the most momentous hyper parameter for the model. The system (4) of calculation of each update with learning rate decay as bellow:

$$LR = initial\_lrate \times (1 / (1 + decay \times iteration)) \quad (4)$$

We have used minimum learning rate reduction 0.000001 and turning down the learning rate quickly reduce the error. We used to call back function to call the learning rate which is supported by Keras. The callback function designed to make a fine-tuning model weight to reduce the learning rate when the model stops improving.

3.2.4 Data Augmentation:

We augmented our train and test data by rotating 30 degrees and the width, height shift range 0.2 where the zoom range is also the same. Transforming training data so that the accuracy and robustness can improve the classifier by the help of data augmentation can generate for each sample x_i the network outputs the selected class label y_i, as well as a probability p_{ij} for each class j [13]. Data augmentation algorithm can be written as:

Using the prediction of the sample the classifier is most sure about:

$$y = \text{argmax}_j \max(\{p_{ij}\}_{1 \le i \le r}) \quad (5)$$

$$\text{Averaging all predictions: } y = \text{argmax}_j \frac{1}{r}\sum_{i=1}^{r} p_{ij} \quad (6)$$

For this paper, data augmentation has played an active role in acquiring recent-most wondrous results in many leaf disease detection tasks and it is used in order to enhance generalization feature. Horizontal flipping, brightness shifts and random RGB color are used with rescaling the image. Before any other processing, we have to multiply the data then it generates a result is known as rescaling value. The color mode of the model is RGB and the RGB coefficients range is 0 to 255 but at this situation, such values can be so much high for processing the model. So we rescale the image (rescale=1. /255) with a horizontal flip.

3.2.5 Training the model:

Experiment is carried out with four convolution layer and two fully connected layers. When we train the model with our unique leaf data sets that give us a better performance. Batch size 30 was used here with 60 epochs. Our model achieves a marvelous fineness accuracy where the training accuracy is 94.62% and test accuracy is 73.44%. The target size of the image is 32 × 32 both for train and test. The CNN model that is using here can classify the image that is all level with different classes can predict the class of the images accurately.

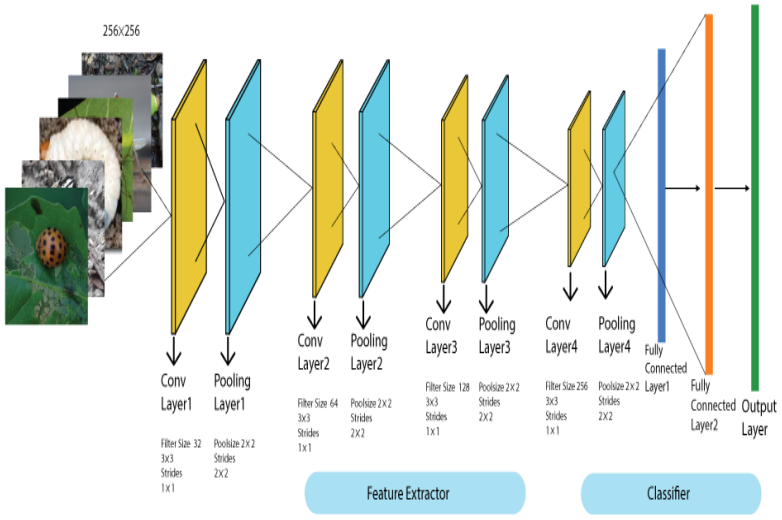


Figure 3.2.3 Convolutional neural network layer

3.3 Data Collection Procedure

All of the data which has been collected from Google and some from manually from the field by smartphone where the images were not in the same size and resolution. When we were trying to train and test the dataset it was very difficult. This version of the dataset containing a fixed resolution of pictures. According to our project requirements, we have converted all images into a square dimension. We made the images to a fixed resolution of 300 × 300 that is the down-sampled of the image. First, we cropped all the images at a variable square dimension for reducing unnecessary objects from the images. Then we scaled it into the required dimension form the cropped images. We use Adobe Photoshop to preprocess all the images. In addition, we trained our model on the RGB color mode.

CHAPTER 4

PERFORMANCE OF THE PROPOSED MODEL

4.1 Training, Testing and the Validation of the model:

We separate training data and test data and validation data and the total images are around 240. About 80% data (190 total) used for training and 20% data (50 total) used for testing for the model. There are some data for validation. Tensor Flow and Keras is used as the image processing deep learning framework. We used categorical mode with RGB color mode and the batch size is 30 both training and testing the data sets. The model which is proposed in the research showing a good performance. Our validation data containing the diseases as like as our train and test data set and also other diseases sign that are unknown for the model look like bellow:

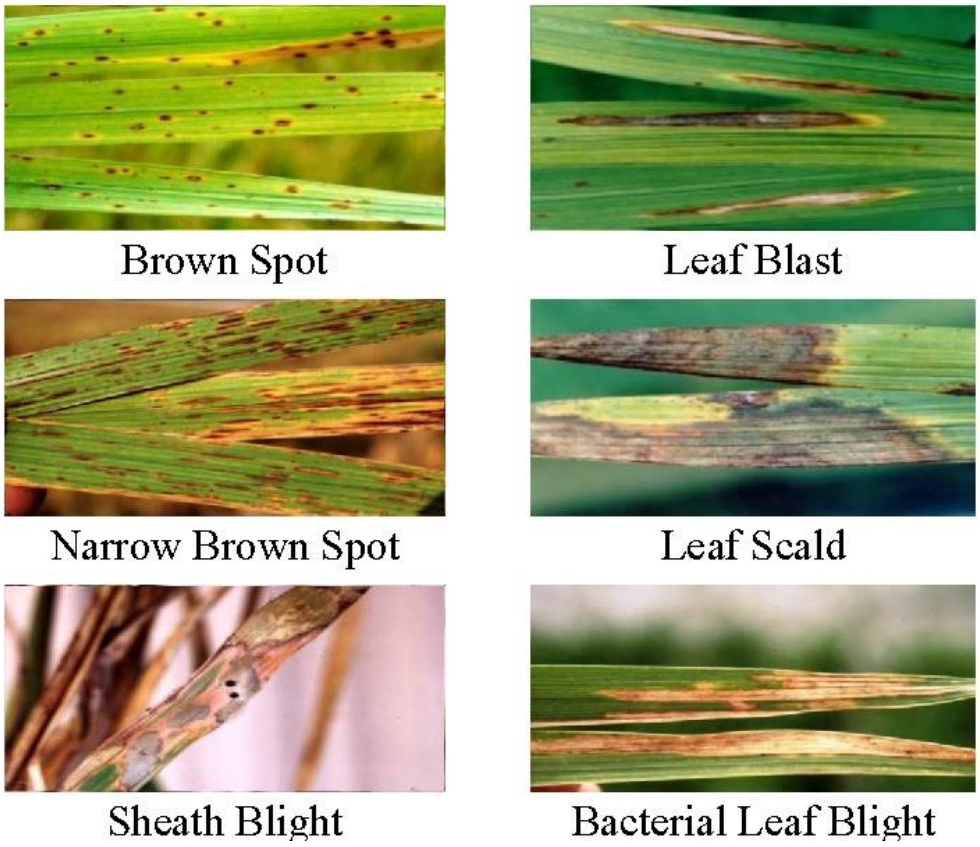
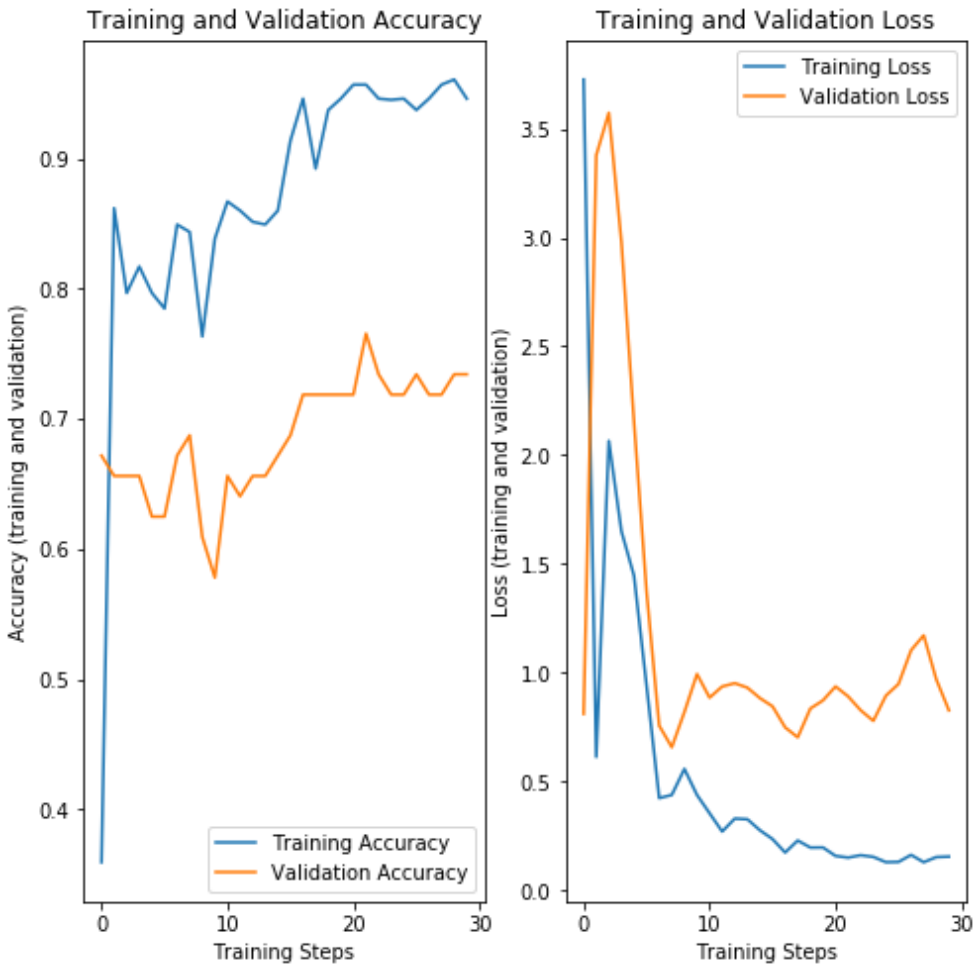


Figure 4.1.1 Validation data

4.2 Model efficiency:

After finishing 60 epochs the model which is used in this work, gained 94.62% accuracy for the training data set that we have made and gained 73.44% accuracy on the testing dataset. Completing the training and testing session the work reaches a successive accuracy rate. Based on the accuracy it can say that the proposed CNN model is admissible for the diseases recognition work. The performance of this work is representing here.



(I) (II)

Figure 4.1.2. (I) Representing training accuracy and validation accuracy. (II) Representing training loss and validation loss

$$\text{Accuracy} = \frac{(TP+TN)}{(TP+TN+FP+FN)} \qquad (7)$$

To describe the performance of the classification model the confusion matrix (7) is extensively used. Here the False positive(FP) rate where observation is negative and negative values predicted as positive, True Positive(TP) rate means observation is positive and is predicted to be positive, True negative(TN) rate where Predicted values correctly predicted as an actual negative and false negative(FN) means Positive values predicted as negatively for each type of dataset.

CHAPTER 5

SOFTWARE REQUIREMENT SPECIFICATION

5.1 Business Process Model

Ignoring business process management altogether is a surefire way to stagnate or, worse, fall behind in the competition. But we don’t think about business here. Both our messenger and chat will be free of cost. There will be a free app on google play store too. Where user don’t have to pay anything to download and use the app.

5.2 Use Case Model

We have designed our model as minimal as we can. We have made it simple to users so that maximum of our user can use it easily.

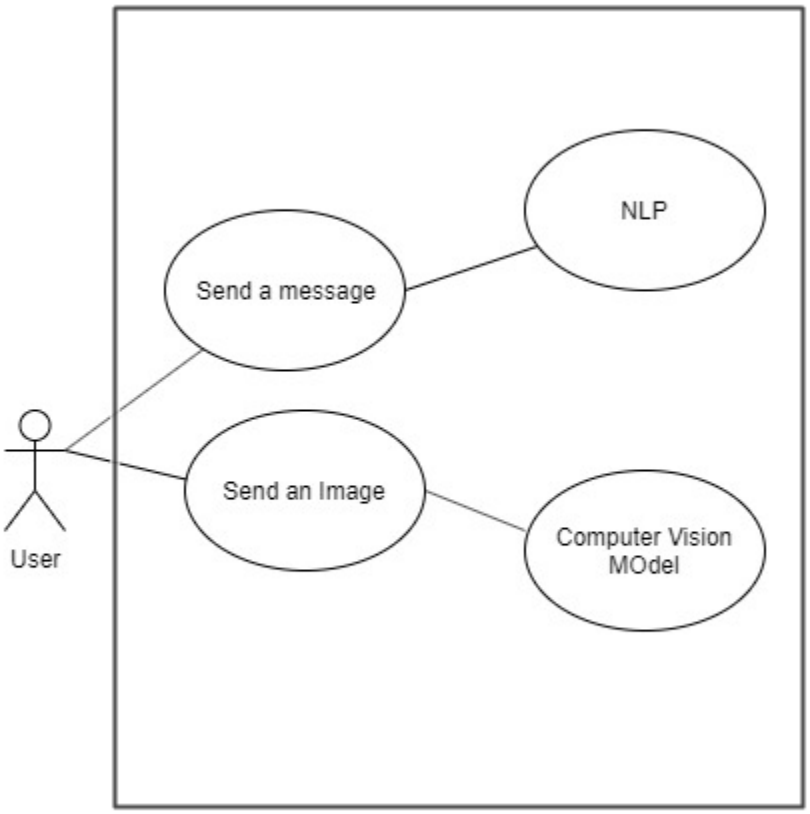


Figure: 5.2.1 Use Case Diagram of Chatbot

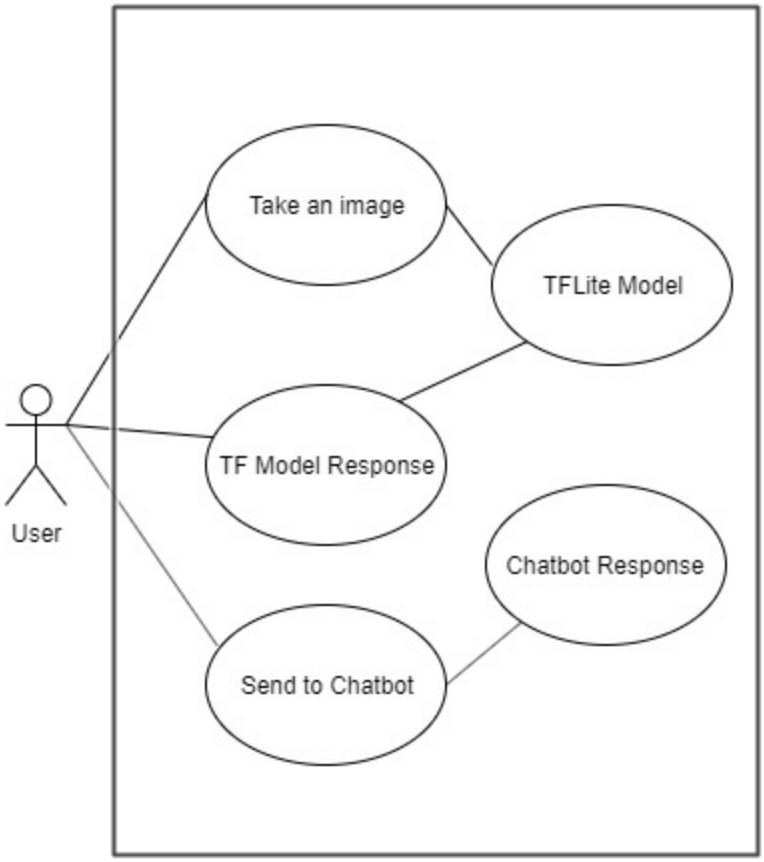


Figure: 5.2.2 Use Case Diagram of Android App

5.3 Design Requirements

We have used TensorFlow and keras to develop the main model to detect diseases. TFLite has been used to detect images in android app. We have converted bitmap to Byte Buffer in app.

Figure: 5.3.1 Android App Design

5.3.1 Front-End-Design (XML):

We have used XML to design our android app.

5.3.2 Tensorflow Backend:

We have used google TensorFlow and train our model and converted it to TF Lite for android. We have use IBM Watson to communicate with messenger server. User can send message in both Bengali and English. The chatbot will promote next predicted input to user.

Figure: 5.3.2 Messenger Chatbot

5.4 Logical Data Model

The next figure describes the Logical Data Model or or Diagram of this project which representing the relationship among the entities. This diagram relation between user to our AI Model.

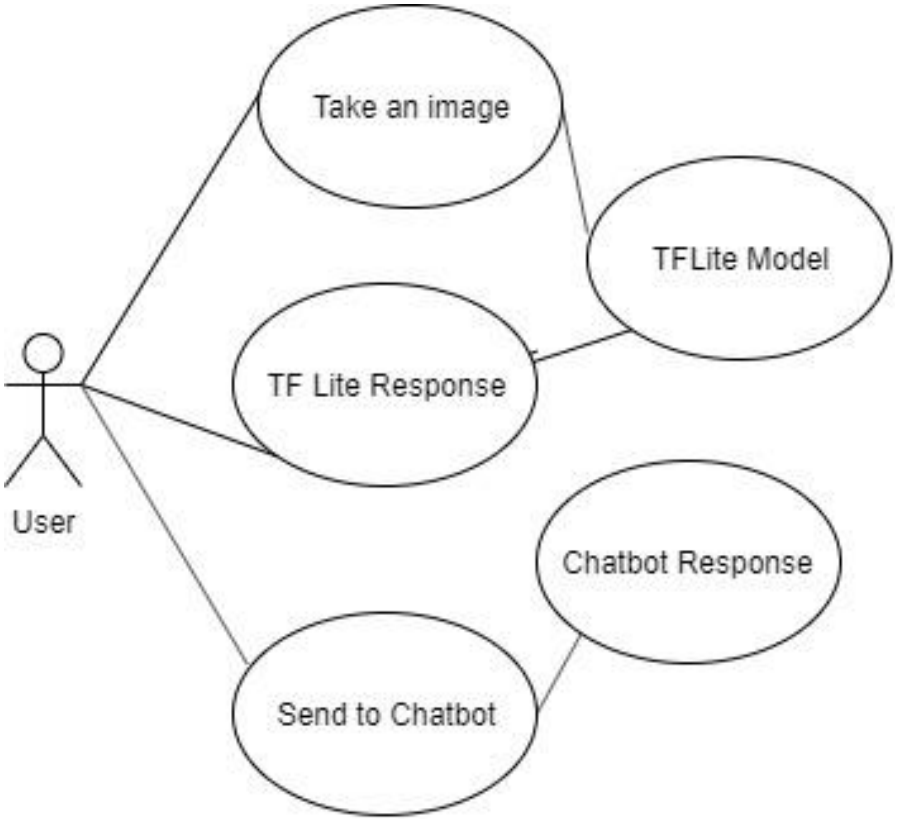


Figure: 5.4.1 Logical Data Model

CHAPTER 6

DESIGN SPECIFICATION

6.1 System Environment

Our chatbot directly connect user to our IBM Watson Server when they send any query. If user send any image our system sends it to our TF model to detect what the diseases actually it is and send the response. User can choose if he/she wants to know more and get help from our chatbot.

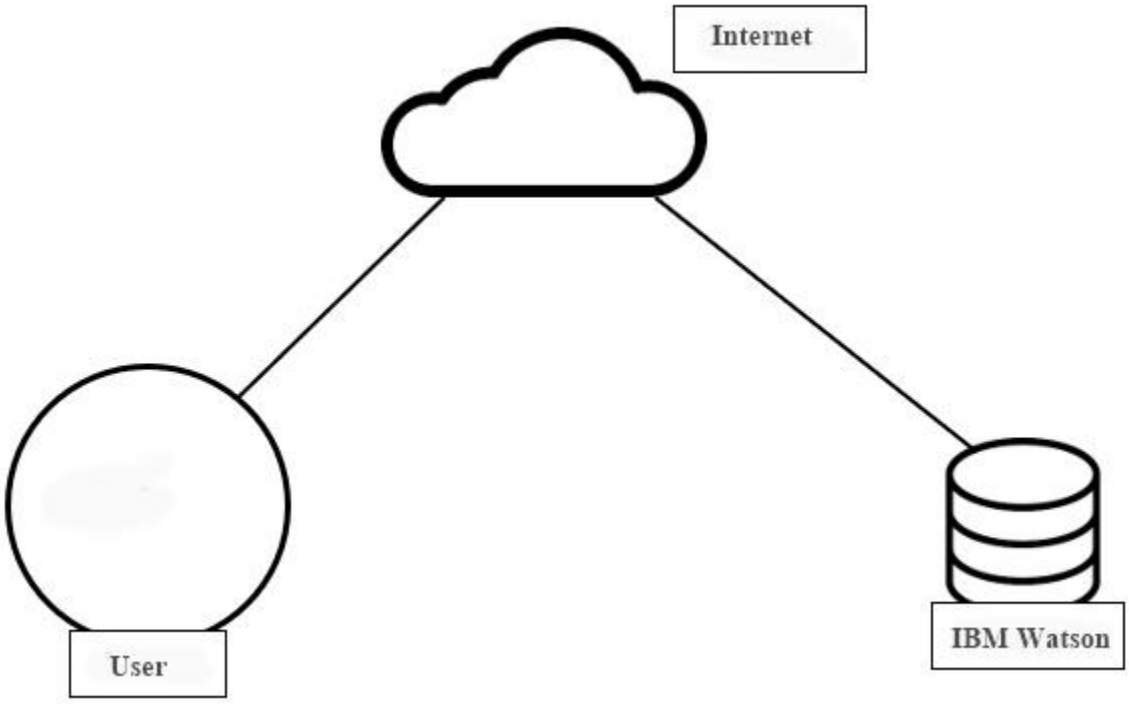


Figure: 6.1.1 System Environment

6. 2 Front-End Design

We have used Java to build the android app. The XML has been used to design the UI of the app. Though the messenger user will see a different interface.

Figure 6.2.1 the Home Page of the system

6.3 Back-end Design

We have used TensorFlow and Keras to design and train the model. Then the model has been converted to TF Lite to use in android project. The given code check the accuracy of prediction.

```
[ ]  for idx, filename in enumerate(random.sample(validation_generator.filenames, 5)):
         print("SOURCE: class: %s, file: %s" % (os.path.split(filename)[0], filename))

         img = load_image(filename)
         prediction = predict(img)
         print("PREDICTED: class: %s, confidence: %f" % (list(prediction.keys())[0], list(prediction.values())[0]))
         plt.imshow(img)
         plt.figure(idx)
         plt.show()
```

Figure: 6.3.1 Checking prediction accuracy

6.4 Testing and Integration

We have used a separated dataset, which wasn't used to train our model to test our model. Here We have found 94.62% accuracy.

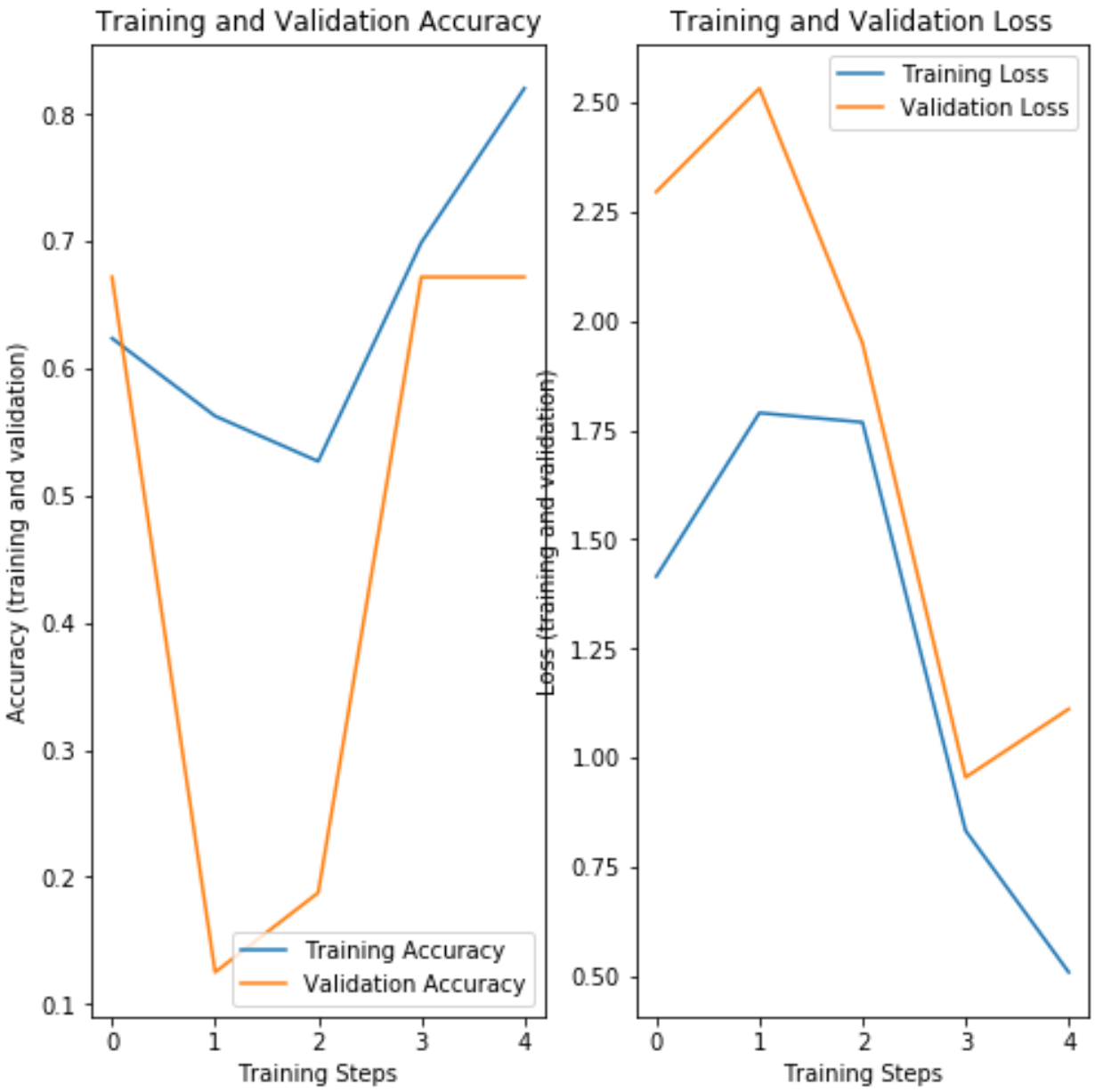
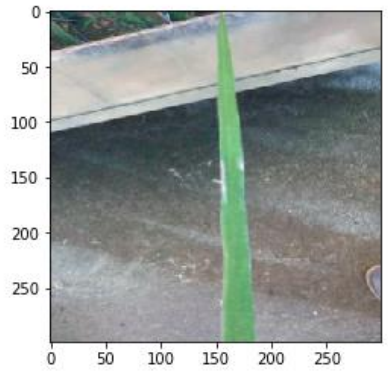
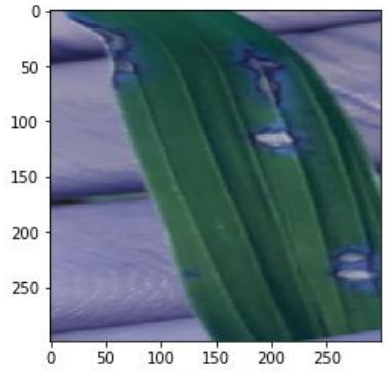


Figure: 6.4.1 Accuracy and Loss Chart.

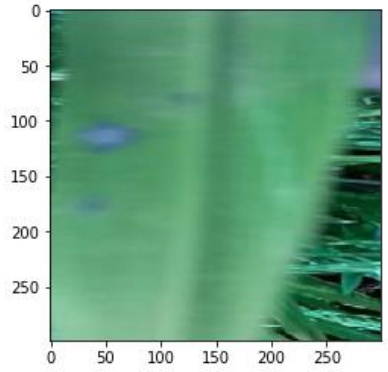
```
SOURCE: class: bacterial_leaf_blight, file: bacterial_leaf_blight/blight_rotated_027.jpg
PREDICTED: class: Bacterial_leaf_blight, confidence: 0.622940
```




```
<Figure size 432x288 with 0 Axes>
SOURCE: class: blast, file: blast/blast_rotated_006.png
PREDICTED: class: blast, confidence: 0.570509
```




```
SOURCE: class: blast, file: blast/blast_rotated_011.jpg
PREDICTED: class: Bacterial_leaf_blight, confidence: 0.946081
```




```
<Figure size 432x288 with 0 Axes>
SOURCE: class: bacterial_leaf_blight, file: bacterial_leaf_blight/blight_rotated_013.jpg
PREDICTED: class: Bacterial_leaf_blight, confidence: 0.991176
```

Figure: 6.4.2 Testing Model

CHAPTER 7

CONCLUSION & FUTURE SCOPE

7.1 Conclusion

This work mainly focuses on leaf diseases detection from any surface by using CNN. We found that CNN is the best way to perform this kind of recognition work. However, this model gains 94.62% validation accuracy where we can nearly identify the image correctly. Although we have a low amount of data set, we have tried our best to get the best accuracy. This type of work can bring a great evaluation in agriculture sector for Bangladesh. Most of the farmer in Bangladesh are illiterate and they can't correctly recognize the leaf diseases and they don't know the exact antidote of the diseases. That's why the diseases gradually destroying the harvest day by day and farmer get to suffer from it. This work can change the situation of the farmer in Bangladesh.

Looking forward our aim is to create an android system without internet connection that can identify the diseases and can give a better antidote for the disease. In future by enhancing our database so that the model can gain far better accuracy and build an android app which is still in the development process. There will be a system where a farmer can get instant service of his problem by detecting the diseases easily.

7.2 Future Scope

Currently, we can detect only three types of diseases. But there are more than twenty rice leaf diseases has been discovered here in Bangladesh. We will try to detected all of those and help our farmers.

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APPENDIX

Appendix A: Survey form for Farmer

Respondent Information:

Respondent Name :
Address :
Date :
Time :

Diseases Name	Visibility			Solution	
	Clear	Blurry	Very Blurry	Known	Unknown
Brown Spot					
Bacterial Leaf Blight					
Blast					

Plagiarism report of Farmabot V2

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