

PLANT LEAF AND DISEASES IDENTIFICATION

BY

ASHIK-E-RABBANI

ID: 161-15-7093

AND

SAMSIL AREFIN

ID: 161-15-7197

AND

ARMAN FAZLUR RAHMAN

ID: 161-15-6991

This Report Presented in Partial Fulfilments of the Requirements for the
Degree of Bachelor of Science in Computer Science and Engineering.

Supervised By

Shah Md. Tanvir Siddiquee

Assistant Professor
Department of CSE
Daffodil International University

Co-Supervised By

Ahmed Al Marouf

Lecturer
Department of CSE
Daffodil International University



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APPROVAL

This Project/internship titled **PLANT LEAF AND DISEASES IDENTIFICATION**, submitted by Ashik-E-Rabbani, ID No: 161-15-7093, Samsil Arefin, ID No: 161-15-7197 and Arman Fazlur Rahman, ID No: 161-15-6991 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 07 Dec 2019.

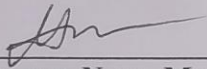
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Faculty of Science & Information Technology
Daffodil International University

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Assistant Professor

Department of Computer Science and Engineering
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Daffodil International University

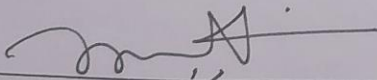
Internal Examiner



Gazi Zahirul Islam
Assistant Professor

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

Internal Examiner



Dr. Mohammad Shorif Uddin
Professor

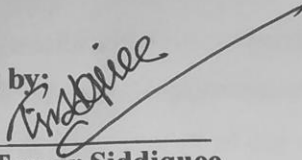
Department of Computer Science and Engineering
Jahangirnagar University

External Examiner

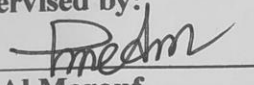
DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Shah Md. Tanvir Siddiquee**, Assistant Professor, 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.

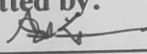
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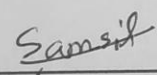

Shah Md. Tanvir Siddiquee
Assistant Professor
Department of CSE
Daffodil International University

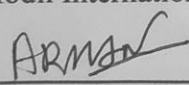
Co-Supervised by:


Ahmed Al Marouf
Lecturer
Department of CSE
Daffodil International University

Submitted by:


Ashik-E-Rabbani
ID: 161-15-7093
Department of CSE
Daffodil International University


Samsil Arefin
ID: 161-15-7197
Department of CSE
Daffodil International University


Arman Fazlur Rahman
ID: 161-15-6991
Department of CSE
Daffodil International University

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ABSTRACT

The economy of Bangladesh is mainly Agricultural. Agriculture is the largest sector in Bangladesh, comprising almost 80% of people's involvement by contributing 21-23% of the GDP. From the beginning of the 21st century, Bangladesh wants to become digital. A lot of sectors has already been digitized. But our Agricultural sector is not digitized so much. So our aim is to contribute our effort to digitize Bangladesh Agriculture sector through our research project. In this project, our goal is to find an easier and smarter way to identify the common diseases of plants using smartphones with minimum camera capability. This could be the best way to take necessary steps to prevent further damages to the plants as it will suggest required solutions to the identified diseases. Also there are no remote way to communicate among the farmers or the agricultural experts. That's why we intend to build a community with both farmers and experts, where they can share their problems and solution. Our objective is to provide supports to the users as much as possible. As this project is based on our agricultural sector, most of our users will be farmers. So it has to be as simpler as it could be that anyone with minimum knowledge of smartphones can use it.

TABLE OF CONTENTS

CONTENTS	PAGE
Board of Examiners	i
Declaration	ii
Acknowledgements	iii
Abstract	iv
CHAPTER	
CHAPTER 1: INTRODUCTION	1-4
1.1 Introduction	1
1.2 Motivation	2
1.3 Rationale of Study	2
1.4 Research Questions	3
1.5 Expected Outcome	3
1.6 Report Layout	3
CHAPTER 2: BACKGROUND	5-10
2.1 Introduction	5
2.2 Widespread Diseases	5
2.3 Related Works	8
2.4 Research Summary	8
2.5 Scope of the Problem	9
2.6 Challenges	10
CHAPTER 3: RESEARCH METHODOLOGY	11-18
3.1 Introduction	11

3.2 Research Subject and Instrumentation	11
3.2.1 Contacting with Image	12
3.2.2 Choosing model	13
3.2.3 Image Pre-processing	14
3.2.4 Training process	14
3.2.5 Verification and accuracy testing	15
3.2.6 Android Deployment	15
3.3 Data Collection Procedure	17
3.4 Statistical Analysis	17
3.5 Implementation requirements	18
CHAPTER 4: EXPERIMENTAL RESULTS DISCUSSION	19-25
4.1 Introduction	19
4.2 Experimental Results	19
4.2.1 Computer Based Experimental Result	19
4.2.2 Mobile Based Experimental Result	20
4.3 Descriptive Analysis	23
4.4 Summary	25
CHAPTER 5: SUMMARY AND IMPLICATION FOR FUTURE RESEARCH	26-27
5.1 Summary of the Study	26
5.2 Conclusions	26
5.3 Recommendations	27
5.4 Implications for Further Study	27
REFERENCES	28

LIST OF FIGURES

FIGURES	PAGE NO
Figure 2.2.1: Leaf Blight of Rice	6
Figure 2.2.2: Brown Spot of Paddy	6
Figure 2.2.3: Tungro Disease	7
Figure 3.1: Proposed working procedure	11
Figure 3.2.1: Disease affected leafs	12
Figure 3.2.2: MobileNet Structure	13
Figure 3.2.4.1: MobileNet model	14
Figure 3.2.4.2: Real-time training process	15
Figure 3.2.5: Training accuracy summary	15
Figure 3.2.6.1: Basic workflow	16
Figure 3.2.6.2: Android Trained Graph placement	16
Figure 4.2.1.1: leaf images (Bacterial Leaf Blight)	19
Figure 4.2.1.2: Predicted Result (Bacterial Leaf Blight identified)	20
Figure 4.2.2.1: Android App (GUI)	20
Figure 4.2.2.2: Image capture of affected leaf	21
Figure 4.2.2.3: Predicted disease and diagnosis	22

LIST OF TABLES

TABLE NAME	PAGE NO
Table 2.3.1: Comparisons among some disease identification application	9
Table 3.4: Confusion matrix of the system	17
Table 4.3.1: Formation of confusion matrix	23
Table 4.3.2: Formation of confusion matrix for Bacterial Leaf Blight	23
Table 4.3.3: Formation of confusion matrix for Brown Spot	24
Table 4.3.4: Formation of confusion matrix for Late blight of potato	24
Table 4.3.4: Confusion matrix result summary	25

CHAPTER 1

INTRODUCTION

1.1 Introduction

Agriculture is the eldest profession in the world. In our country, most of the people rely on agriculture or agricultural business for their living. Despite being the most important profession in the country, this sector is not using technology as it should be. Our objective is to contribute to this sector by creating something that can reduce the gap between field farmers and agricultural experts. In this project, we are giving the opportunity to find any disease just by scanning the plant leaf. We are also suggesting solutions for particular diseases. This will help reduce the loss of crops as the farmer can recognize the disease earlier by himself and can also give treatment to the plants. It will also save time and money as they do not have to go to experts for these problems. Also if they can find out the disease earlier, the damage would be to a minimum.

Most farmers in this country are not much educated. Also, they are not used to technology that much. It is the reason we wanted to make our project as possible and user-friendly. The farmers from different parts of the country use different effective ways to cultivate their crops. They also face different kinds of problems too. But there is no way to communicate among the farmers from different regions. That is why we have added a part that will help the users to build a community. In the community, farmers from different parts of the country can communicate with each other. They can also give a solution to different problems from their experience.

Our project also has the basic contacts of nearest helplines from agricultural departments. It is an offline application that will allow users to operate the application without being connected to the internet.

1.2 Motivation

As being raised in the rural areas of our country, we always wanted to do something to contribute to improvements to this area. In the rural areas, we have seen that farmers use ancient techniques to cultivate their crops. They are using this technique for generations. They are not familiar with the new inventions that can improve their cultivation process. Crops take major damages as the farmers cannot provide the appropriate treatment to the plants because they fail to recognize the diseases correctly. It takes too much time to give treatment to the plants after consulting with the experts. Most of the areas do not have enough agricultural experts to give support to the farmers. The experts also face difficulties to reach the farmers.

There has been some related to this particular sector but none of them did sufficient work in the field. Also, we tend to make a more user-friendly environment for the users. We wanted to build a platform to decrease the slit amid the farmers and agricultural experts. It will also help the agricultural experts to reach difficult parts of the country and find new kinds of diseases. Our platform will also help the farmers to know about the new techniques and innovations to cultivate their crops more efficiently.

1.3 Rationale of the Study

The agricultural sector is emerging gradually as the government knows the importance of this sector. Many researchers have tried to find the most efficient way to trace diseases of the plants. They have also presented some feasible ways to find and give solutions according to diseases. There are also some mobile applications available that can trace some diseases. But the key complication of these applications is that they are not user-friendly and requires a working internet connection to use. The problem is that most of the people in some of our rural areas do not have internet access. So, they cannot use the applications properly even after they have the applications. Researchers are working to find the patterns of the contaminated leaves to find new solutions. They have already listed some new diseases by analysing the diseased leaves. But they are facing problems reaching the victim farmers. Developers are still trying to give easier ways to solve the problems.

1.4 Research Questions

- What are the major rice plant diseases?
- Which things cause most of the diseases?
- What are the solutions to the diseases?
- What are the conditions of a leaf in different stages of a disease?
- Does the leaf have any patterns while being contaminated by the disease?
- What are the difficulties for farmers to communicate with the agricultural officers about their problems?
- What are the difficulties for farmers to communicate with other farmers from different areas about their problems?

1.5 Expected Outcome

In this research, we tried to find a greater way to help the users detect plant diseases and provide them with the required solutions. We implemented an ingenious application to experiment with the projected proposition. The fundamental objective of this application is to detect the plant diseases using images of the contaminated leaves provided by the users. The application also has some additional options for the users, some of them are:

- Ability to detect plant leaves and if the leaf has any disease
- Capability to suggest required solutions for the detected problems
- Build a community that will reduce communication among farmers and agricultural experts
- Adeptness to work perfectly without internet connection
- Facility to provide emergency helpline contacts
- Containing the basics things to do to prevent major diseases

1.6 Report Layout

Chapter 1: Introduction

We have introduced our research topic, the motivation behind this research, the rationale of the research study, the questions raised before starting the research and the expected output of the research. This chapter also has the report layout.

Chapter 2: Background

This chapter contains an introduction, the works related to this research and a summary of the analysis of those related works. It also contains the scope and challenges we can face to implement this research.

Chapter 3: Research methodology

In this chapter, we have an introduction to our research subject and instruments. Here we showed how we collected the data and also the statistical analysis of the collected data. This thing we needed to complete the research is described here.

Chapter 4: Experimental results and discussion

Here we have the results of testing our archetype application and the descriptive analysis of the results.

Chapter 5: Summary and implication for future research

In this chapter, we have the summary and conclusion of the research study. We also have some recommendations and suggestions for further study of this research.

CHAPTER 2

BACKGROUND

2.1 Introduction

Plant leaf disease identification has always been a popular research topic in the world. Different researchers used different ways to detect diseases in the plant leaves. To make an efficient way to trace the disease and provide solutions to users in time, the researchers are working uninterruptedly. The Government has also taken some innovative steps to enhance the disease identification process and financing the researchers to maintain their research. Some of the projects are already on the field and doing quite well to provide support to the users.

Plant leaves are the best way to identify if the plant is contaminated or not. There are some other symptoms that can indicate a diseased plant. But those are hard to detect without doing comprehensive tests on the plants by a farmer. By analysing a leaf, a lot of things about a disease can be detected. The differences among the symptoms of different diseases cannot be identified by farmer's bare eyes. There are some common treatments for most of the diseases, but sometimes a slight misjudgement can do enormous damages to the crops. The farmers are not continually able to detect diseases correctly. It gets too late to reach the agricultural experts about the diseases. Some researchers have successfully been able to help the farmers detecting diseases by themselves. But there is a lot of work to do to improve this sector.

2.2 Widespread Diseases

Rice is the most cultivated crop in Bangladesh. Most of the farmers cultivate rice in their lands. There are numerous types of rice diseases in our country. The diseases could be bacterial, fungal, viral and nematode and micronutrient absence related. Most of the diseases affect the leaves of the plant. The 3 most widespread diseases of rice are described below.

- **Bacterial Leaf Blight:** Bacterial leaf blight is the most widespread disease of rice which causes devastating damages to the crops every year. This causes the wavy yellow marginal necrosis and eventually rescinding the plants. This disease is caused because of unnecessary weeds in the fields, humid weather, presence of bacteria, sudden rain, etc.



Figure 2.2.1: Leaf Blight of Rice

- **Brown Spot:** Brown spot of rice is a fungal disease. It causes round or oval shapes of a spot with brown margin. It also affects the seed of rice and causes them to dry. The fungus remains in the contaminated after a long time. The residual funguses later attack another field with the help of water, air and some weeds in the field.

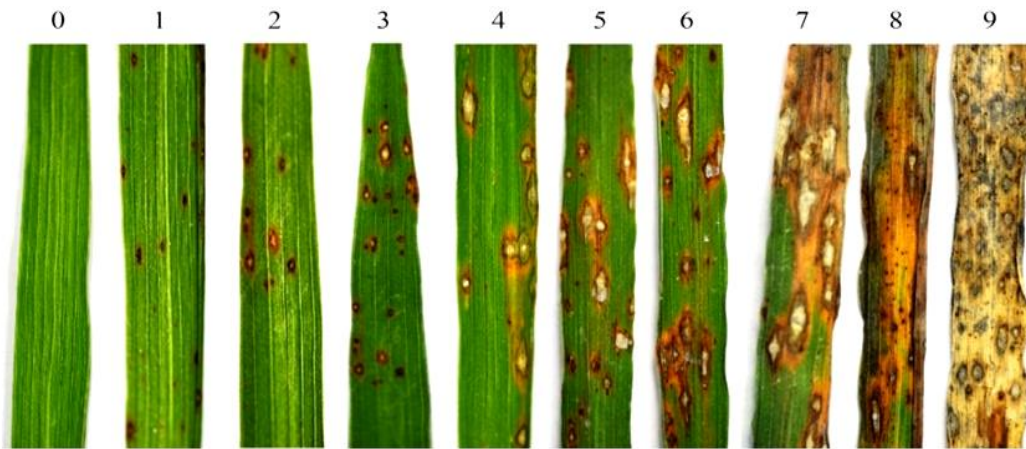


Figure 2.2.2: Brown Spot of Paddy

- **Tungro Disease:** Tungro disease spread from top to bottom of the leaf with yellow, orange-yellow or rust-colour spot. This causes the flowering process to slow down and sooner or later destroy the plant. This disease is caused by Tungro virus which spreads by grasshoppers mainly.



Figure 2.2.3: Tungro Disease

2.3 Related Works

Many researchers have already given different and efficient approaches to identify leaf diseases from images. There are some mobile applications already available. Developers have applied different formulas to detect diseases from images.

Plantix Mobile Application receives images of damaged crops from the users and matches them with the contaminated plant leave's database. The image recognition software finds out which one the diseased leaf has the highest match with the given images. It can also detect if the given image of the plant is suffering from malnutrition or not. It can provide expert advice based on the analysis of the given image. This application needs internet-enabled smartphones to analyse the leaf as the image is sent to image recognition software which is connected to the server to match with the contaminated leaves datasets.

Fosholi Mobile Application is mostly based on the environment of Bangladesh. It provides various information needed before, during and after any kind of cultivation. This application delivers expert suggestions and services to the farmers in any stage of cultivation. This app does not offer to identify plant diseases through image processing, although it can help solving so many problems if the problems can be detected somehow.

Leaf Doctor Mobile Application can calculate the percentage of diseased tissue of a leaf. The user can provide an image of a leaf and have to select some areas to let the system identify the healthy areas of the leaf. Then the system compares the healthy areas with the rest of the areas and calculates the contaminated areas of the leaf.

2.4 Research Summary

After using numerous mobile applications, there are some recognized applications that can successfully detect diseases from plant leave's images. But from our analysis, we have found out some features that are not in the available applications. Most of the applications need internet-enabled smartphones to detect diseases. The Internet is not always available in the rural parts of the country. Secondly, the internet has some costs too. So, this is one of the features we wanted to include in our project that everyone can use it without any

internet connection. Some applications also have various helplines and problem sharing community. After making an allowance for the rural areas of the country and the people living there, we have listed the necessary missing features of the popular applications and included them in our project. Here are some of the differences between our project and the applications available in the market right now

Table 2.3.1: Comparisons among various disease identification application

Application	Disease Detection	Offline Detection	Help Line	Problem Sharing Community	Disease Directory	Day Plan Upon Weather	Monthly Cultivating Plan
Plantix	Y	N	N	Y	Y	Y	N
Fosholi	N	N	N	N	Y	N	N
Leaf Doctor	Y	N	N	N	N	N	N
Our	Y	Y	Y	Y	Y	Y	Y

2.5 Scope of the Problem

Our proposed system mostly hinges on the images provided by the users. The provided images will be evaluated; therefore, a breakdown report will be created by the system. If the images contain any known type of leaves, the system will look for symptoms of diseases. So, the whole system depends on the images. Image processing has some great opportunities in the research area. Diseases detection from an image is just the primary research area of image processing. This process can be used in different fields. For automatic detection, the system needs to learn about patterns and different symptoms of diseases. If this system works on rice, the same system can be used in almost every kind of plant in the world.

2.6 Challenges

Plant leaf disease identification by image processing has been relatively widely held throughout the world because of its comparatively easier process. It can reduce the number of damages to crops significantly. But due to its dependency on the images provided by the users, it has some difficulties to perform correctly. The most concerning matter about this application is that the major users targeted for this application are rural people and farmers. In our country most rural peoples and farmers are uneducated. They are also not familiar with smartphones. Although the price of smartphones with minimum camera capabilities is decreasing day by day, most of the farmers cannot afford them. Secondly, the provided images need to be clear and the background has to be such a way that the leaf can be easily separated. Even if the image quality is up to the mark, sometimes the system cannot identify the disease correctly. Different diseases produce similar symptoms sometimes. The similar kinds of diseases cannot be differentiated just by analysing the leaves. Also, every disease has different types of effects on the leaves on different stages. As the system cannot give any solutions if it cannot identify the diseases correctly.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

To discern the infected area of leaf perfectly, the dataset's image should be well trained first. Otherwise, we will not get the results we want. Fig 3.1 bestows on the indispensable steps to overcome the plant leaf disease classification. Here in this thesis to overcome our problem TensorFlow is used. In TensorFlow it has its own feature extraction ability is known as model. As a neural network model mobileNet model is used. Beside all these components python 3.5 and java is used as communication language among all operations, software, and platform. Fig 3.1 shows the path of the journey regarding this research.

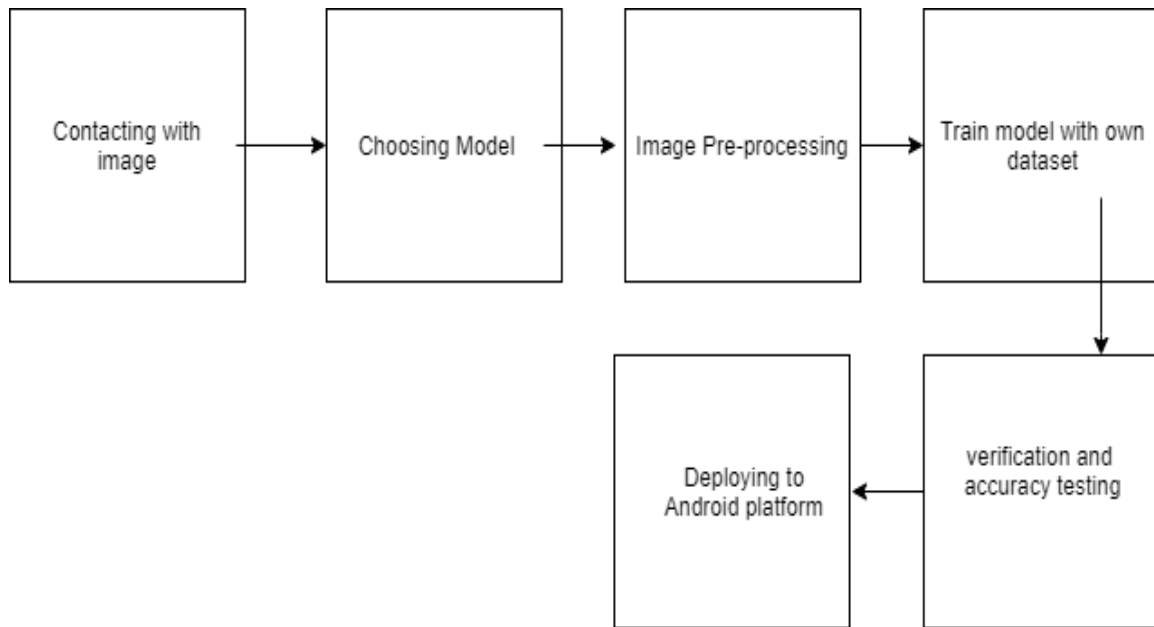


Figure 3.1: Proposed working procedure

3.2 Research Subject and Instrumentation

Processing the provided images correctly the images needs to clean. We have collected our desired dataset from different areas of the country. We contacted several agricultural experts from more than a few agricultural institutions throughout the country. The process we followed to train the dataset and dispensation of the provided images are discussed below.

3.2.1 Contacting with Image

In the era of image processing contacting with image means addressing images from various sources by using hardware-based devices like cameras, mobile cameras. This is the primary credential of processing digital image. The raw image is sent to the next process to parse the expected outcome from it. The journey of this thesis is contained with various plant leaf images that are collected from copious places. The images have some unique features which differ one from another genre. An image is basically a form of three primary colours known as RGB values. Those images have some discrepancies in essence and formation which need to process in a standard manner to train the dataset.

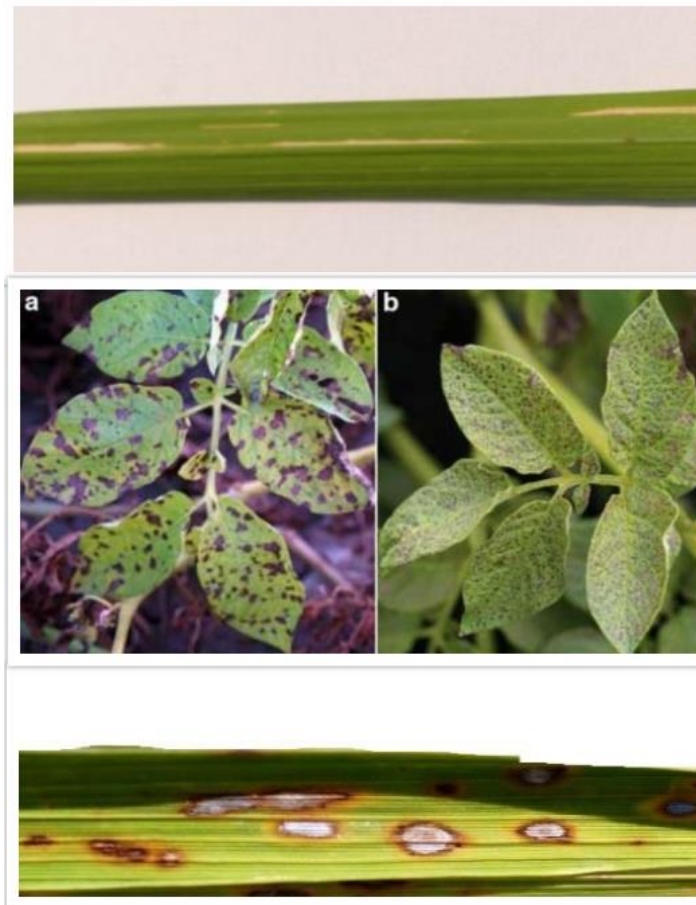
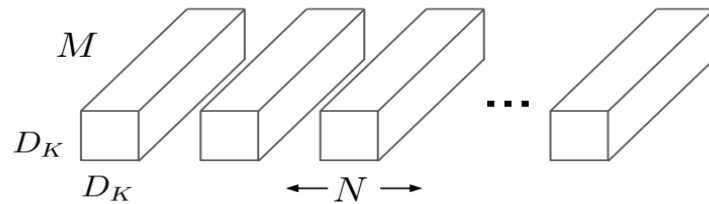


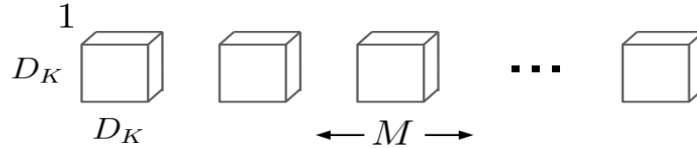
Figure 3.2.1: Disease affected leaves

3.2.2 Choosing Model

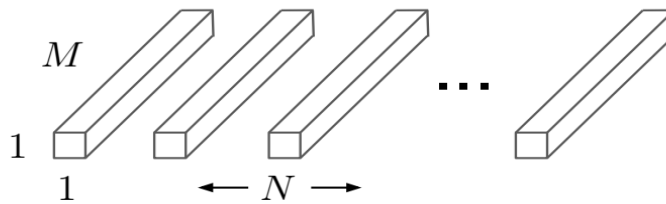
In this phase, we need to choose a model to train our dataset. Various types of models are available on the Tensorflow choosing the right one is more adventitious. A neural network is capable of finding a complex relationship between the features and the label. A model is an organized structured graph having one or multiple hidden layers. Those hidden layers are consisting of one or multiple neurons. Present targeted neurons in a layer perceive input connections from every neuron in the previous layer. For this thesis, we used the mobileNet Tensorflow model which has high-level accuracy for medium size datasets.



(a) Standard Convolution Filters



(b) Depthwise Convolutional Filters



(c) 1×1 Convolutional Filters called Pointwise Convolution in the context of Depthwise Separable Convolution

Figure 3.2.2: MobileNet Structure

3.2.3 Image Pre-processing

In this step, we need to label our data until our learning method of CNN copes up with the machine learning model. While processing images, they should be cropped in a similar dimension to achieve better accuracy.

3.2.4 Training Process

As we are using the mobileNet model of Tensorflow a working tragedy is given below. In this model, the output layer is labelled as the “softmax” of the original layer. The nodes are on the right side of the label “softmax” were further supplemented by the reskilling script. And the dataset data is given as train data in this model.

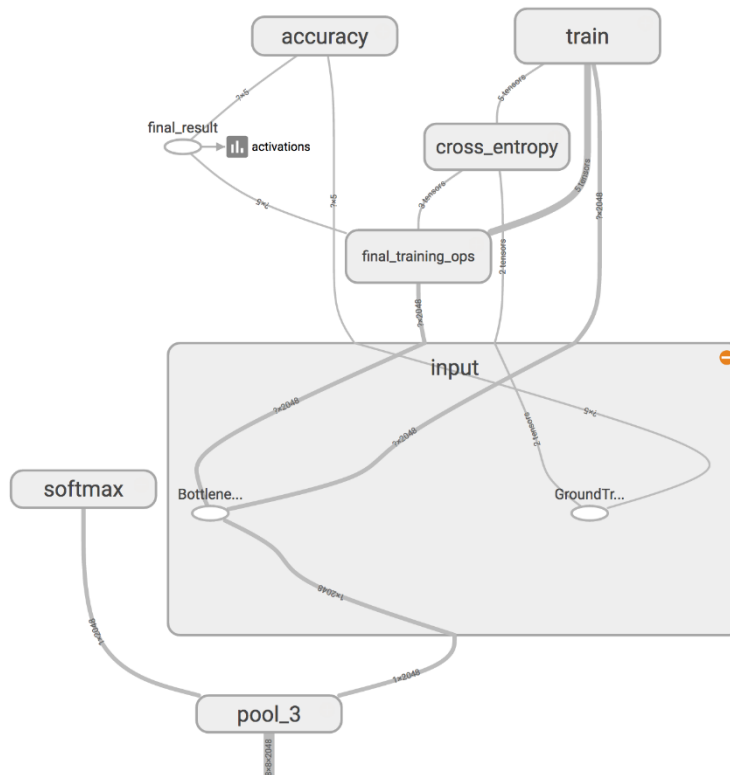
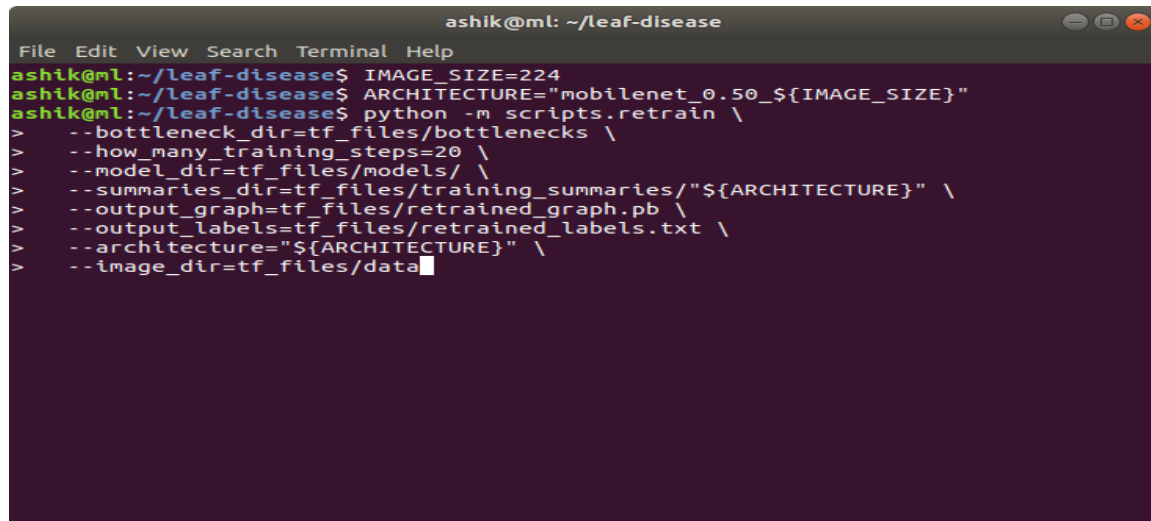


Figure 3.2.4.1: MobileNet model

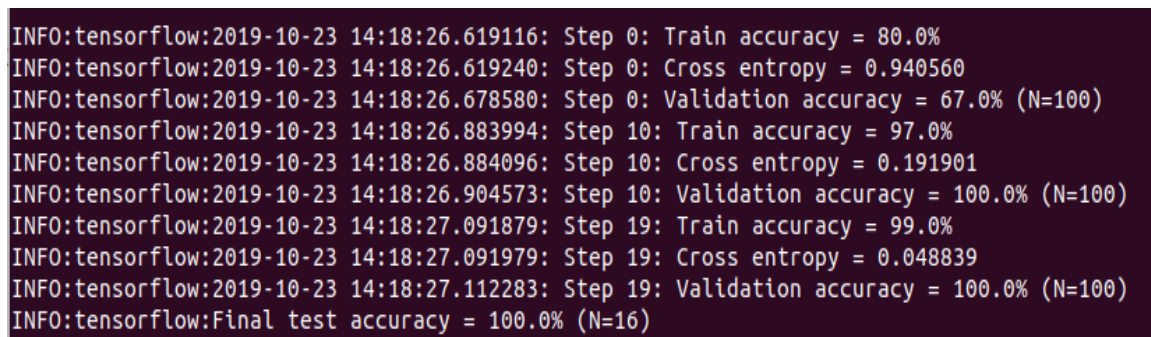
A terminal window titled 'ashik@ml: ~/leaf-disease' with a menu bar (File, Edit, View, Search, Terminal, Help). The terminal shows the following commands and their outputs:

```
ashik@ml:~/leaf-disease$ IMAGE_SIZE=224
ashik@ml:~/leaf-disease$ ARCHITECTURE="mobilenet_0.50_${IMAGE_SIZE}"
ashik@ml:~/leaf-disease$ python -m scripts.retrain \
> --bottleneck_dir=tf_files/bottlenecks \
> --how_many_training_steps=20 \
> --model_dir=tf_files/models/ \
> --summaries_dir=tf_files/training_summaries/"${ARCHITECTURE}" \
> --output_graph=tf_files/retrained_graph.pb \
> --output_labels=tf_files/retrained_labels.txt \
> --architecture="${ARCHITECTURE}" \
> --image_dir=tf_files/data
```

Figure 3.2.4.2: Real-time training process

3.2.5 Verification and Accuracy Testing

For verification purposes, we use some random disease images from field, social media and search engines where images contain the disease we are working on. After that, we put the image as an input to our model and finally, it makes its classification journey and shows us the final result.

A terminal window showing the training accuracy summary with the following output:

```
INFO:tensorflow:2019-10-23 14:18:26.619116: Step 0: Train accuracy = 80.0%
INFO:tensorflow:2019-10-23 14:18:26.619240: Step 0: Cross entropy = 0.940560
INFO:tensorflow:2019-10-23 14:18:26.678580: Step 0: Validation accuracy = 67.0% (N=100)
INFO:tensorflow:2019-10-23 14:18:26.883994: Step 10: Train accuracy = 97.0%
INFO:tensorflow:2019-10-23 14:18:26.884096: Step 10: Cross entropy = 0.191901
INFO:tensorflow:2019-10-23 14:18:26.904573: Step 10: Validation accuracy = 100.0% (N=100)
INFO:tensorflow:2019-10-23 14:18:27.091879: Step 19: Train accuracy = 99.0%
INFO:tensorflow:2019-10-23 14:18:27.091979: Step 19: Cross entropy = 0.048839
INFO:tensorflow:2019-10-23 14:18:27.112283: Step 19: Validation accuracy = 100.0% (N=100)
INFO:tensorflow:Final test accuracy = 100.0% (N=16)
```

Figure 3.2.5: Training accuracy summary

3.2.6 Android Deployment

In this Segment Tensorflow lite is used as development tools that interpret the trained model. At the end of computer-based training, we got a trained model in “pb(proto buffer)” format now need to convert it to “tflite” format. Here before using TensorFlow Android

API, we need to convert first so in this time the “pb” file is converted by using “toco”, a TensorFlow lite converter. Having the “tflite” file its time to put file in Android API as an assets file.

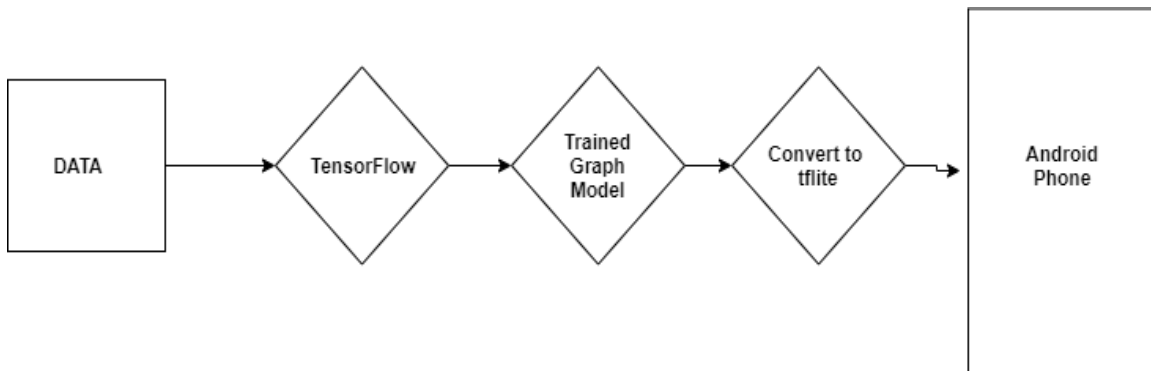


Figure 3.2.6.1: Basic workflow

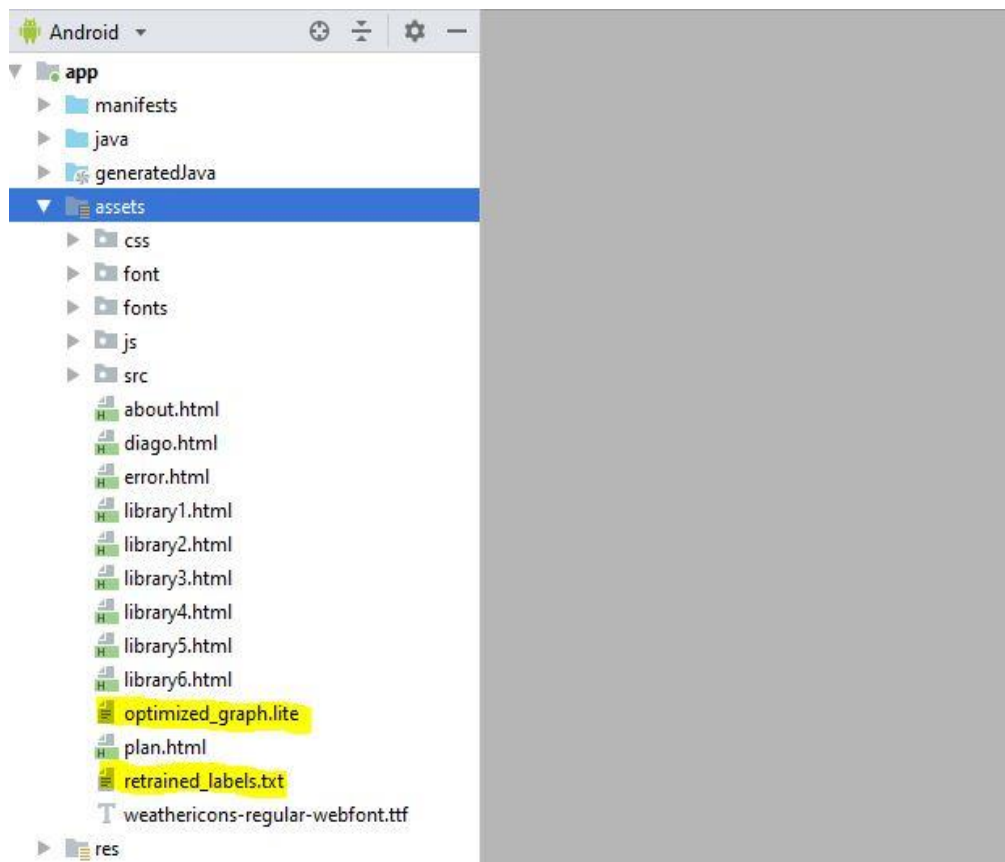


Figure 3.2.6.2: Android Trained Graph placement

3.3 Data Collection Procedure

Required data for our dataset is collected from various places of Bangladesh also from the internet too. The disease statistics higher priority wise information is collected from Bangabandhu Sheikh Mujib Agricultural University with the help of professors of this university. After collecting all those data, we labelled the image with a similar shape and generalize the collected information to get them all in a suitable form of data.

3.4 Statistical Analysis

Through our data analysis, we have come to realize that our system is obtained 89% validation accuracy in 20 steps of training summary. Alongside our system also achieved 94% training accuracy on 500 steps. To calculate the accuracy of labels attributes are extracted with the help of generating confusion matrix.

TABLE 3.4: CONFUSION MATRIX OF THE SYSTEM

	Positive	Negative
True	5	9
False	11	161

For measuring the accuracy and other parameters our available variables are TP, TN, FP, and FN.

Calculation for sensitivity formula is $TPR = TP / (TP + FN)$. And our obtained sensitivity for this confusion matrix is $0.3125 \sim 31\%$.

Calculation for precision formula is $PPV = TP / (TP + FP)$. And our obtained precision for this confusion matrix is $0.3571 \sim 35\%$.

Calculation for specificity formula is $SPC = TN / (FP + TN)$. And our obtained specificity for this confusion matrix is $0.9471 \sim 94\%$.

Calculation for Accuracy formula is $ACC = (TP + TN) / (P + N)$. And our obtained accuracy for this confusion matrix is $0.8925 \sim 89\%$.

3.5 Implementation Requirements

For implementing this system, the TensorFlow environment with Python 3.5 should be available on the computer. To identify diseases, we know that we must need a sound quality at pictures with high resolution for better output. Image processing is actually a part of computer vision. For this project case, the particular image output is generated through neural network processing. So using a portable device like a camera for or mobile cameras to capture the images will be more advantageous. After that, a good powerful GPU is recommended to save our precious time. Training and model required a lot of time so to save our time, the training system should be faster to achieve a faster output.

CHAPTER 4

EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Introduction

There are 186 sample images used in several phases of the system. There are both computer-based and mobile application based experimental results shown here. The system is capable of detecting 3 different diseases of rice right now. Both of the systems are not internet dependable and can be used without connecting to the internet. The weather forecast was also tested along with the image processing testing. In this chapter, we will briefly describe the experimental results for both computer and mobile-based systems.

4.2 Experimental Result

Experimental results for both computer-based and android mobile application capable of detecting 3 major rice leaf diseases. The images provided in this experimentation are selected indiscriminately from different sources.

4.2.1 Computer Based Experimental Result

This paper demonstrates the identification of plant leaf disease that occurred on the plant leaves. Three different types of plant leaf-based disease were identified by our approaching system. The disease we work on is Bacterial Leaf Blight of Paddy contains 61 images as training data, Brown Spot of Paddy contains 66 images as trained data and Late Blight of Potato contains 59 images as train data in total 186 images are used to train the model of



Figure 4.2.1.1: Leaf images (Bacterial Leaf Blight)

After training the dataset using the mobileNet model with the help of TensorFlow, a test image is placed in a neighbor directory of the dataset. Then via the terminal command, we send the test data to classify by our trained model. In Figure 4.2.2, the predicted class/label is showing on the priority based on their accuracy. Here we can see that our proposed system has 96% accuracy which was evaluated within 60 milliseconds.

```
Evaluation time (1-image): 0.062s  
bact leaf blight (score=0.97840)  
brown spot (score=0.02138)  
potato blight (score=0.00021)  
ashik@ml:~/leaf-disease$
```

Figure 4.2.1.2: Predicted Result (Bacterial Leaf Blight identified)

4.2.2 Mobile Based Experimental Result

In this session, we deploy our computerized system on the Android platform to bring this system to everyone's hands. In that case, we take our system trained model and integrate it

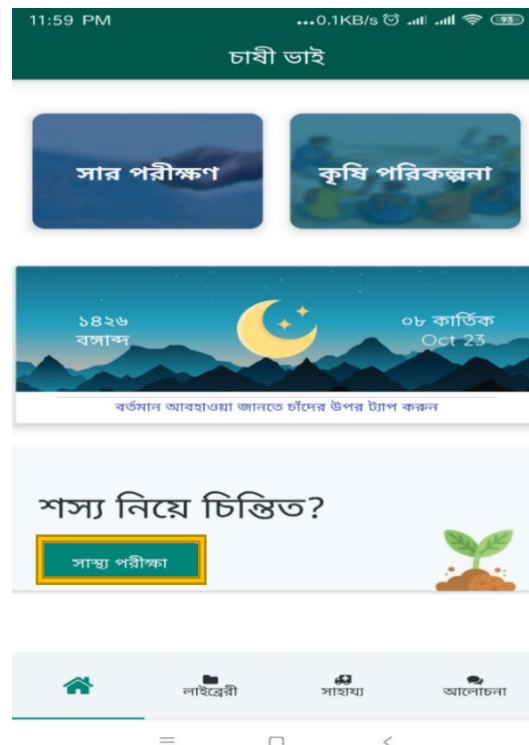


Figure 4.2.2.1: Android App (GUI)

into the android system by using the language communication medium called java. Figure 4.2.2.1 shows the GUI of our Android app to where our trained model is integrated.

In our android App GUI by clicking on the yellow marked area the app changes its activity to capturing image activity. Figure 4.2.2.2 shows the camera activity where we capture the targeted data image. The bottom centre camera button is used to capture the image and also the right bottom swap icon is used to swap between front and rear cameras of the mobile phone.

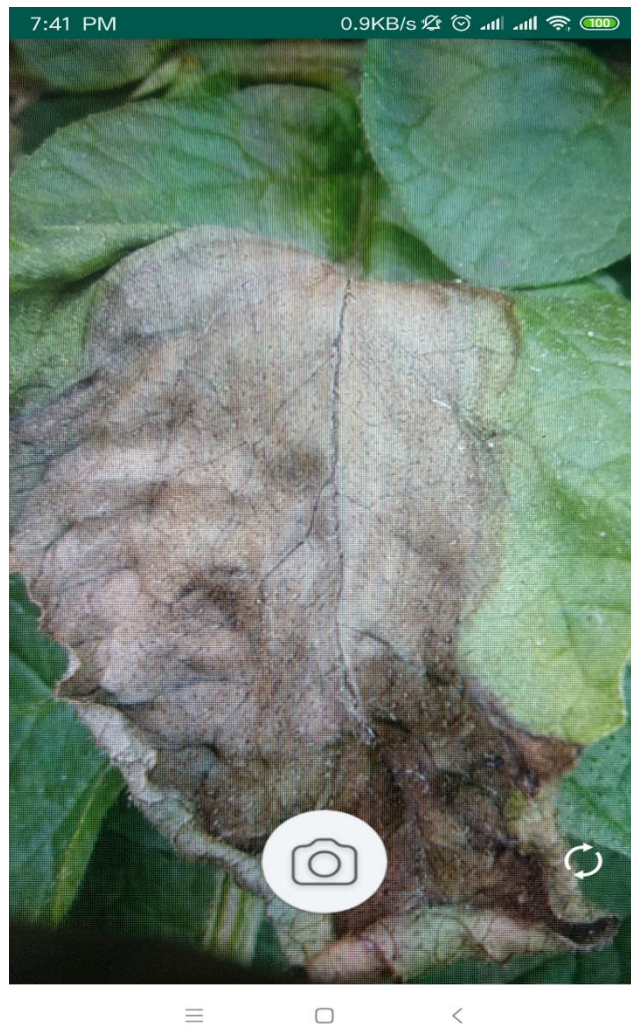


Figure 4.2.2.2: Image capture of affected leaf

After the image capturing phase, the system shows the predicted result in a well-structured and formatted manner. Besides all this, it also shows the accuracy of the predicted result.



Figure 4.2.2.3: Predicted disease and diagnosis

4.3 Descriptive Analysis

The evaluation speed performance can vary for the processing speed of a CPU. But the prediction performance can be analysed through the confusion matrix. To do this very first we need to define some term, they are the number of cases that are identified correctly is known as True Positive (TP). Similarly, incorrect cases are known as False Positive (FP). On the same pattern, another two terms are True Negative (TN) and False Negative (FN). Our system is working upon three classes everyone's confusion matrix (2 x 2) giving on the below tables.

TABLE 4.3.1: FORMATION OF CONFUSION MATRIX

	Positive	Negative
True	TP	TN
False	FP	FN

- a) Accuracy: The mathematical estimator of accuracy is $(TP + TN) / (P + N)$.
- b) Sensitivity: The mathematical estimator of sensitivity is $TP / (TP + FN)$.
- c) Specificity: The mathematical estimator of specificity is $TN / (FP + TN)$.
- d) Precision: The mathematical estimator of precision is $TP / (TP + FP)$.

TABLE 4.3.2: FORMATION OF CONFUSION MATRIX FOR BACTERIAL LEAF BLIGHT

	Positive	Negative
True	3	5
False	2	51

Result from the matrix are Accuracy: 88%, Sensitivity: 60%, Specificity: 91%, Precision: 38%.

TABLE 4.3.3: FORMATION OF CONFUSION MATRIX FOR BROWN SPOT

	Positive	Negative
True	4	3
False	6	53

Result from the matrix are Accuracy: 86%, Sensitivity: 40%, Specificity: 94%, Precision: 57%.

TABLE 4.3.4: FORMATION OF CONFUSION MATRIX FOR LATE BLIGHT OF POTATO

	Positive	Negative
True	3	5
False	2	49

Result from the matrix are Accuracy: 88%, Sensitivity: 60%, Specificity: 90%, Precision: 38%.

TABLE 4.3.4: CONFUSION MATRIX RESULT SUMMARY

	Accuracy	Sensitivity	Specificity	Precision
Bacterial Leaf Blight	88%	60%	91%	37%
Brown Spot	86%	40%	94%	57%
Late blight of potato	88%	60%	90%	38%

4.4 Summary

The sole purpose of this application is to detect diseases in contaminated leaves. We have run several tests to find out the accuracy of the application. Finally, the accuracy of our mobile-based system is 89% considering all other features within minimum time.

CHAPTER 5

SUMMARY AND IMPLICATION FOR FUTURE RESEARCH

5.1 Summary of the Study

Though the foremost occupation in our country is agriculture, this sector is not as improved as it should have been. The farmers are using their ancient methods to cultivate their lands and fight diseases. This is causing huge damages to their crops as the bacteria, viruses and the other harmful insects are becoming immune to the frequently used medicines. Besides most of the farmers cannot identify the diseases flawlessly. That is why we tend to make a system that will help the users identify the diseases of a plant and suggest necessary steps to cure the diseases. The users will provide the images of a damaged plant's leaf and the system will detect what kind of plant it is and if it contains any disease. If the leaf is contaminated, the system will suggest some medications that are necessary to cure the disease. Although there is some mobile application in the market that is being used to detect diseases from a leaf. But we have analysed those applications to find out the defects of those applications. So, our main objectives were to make a better system than the system that is existing right now in the market. Besides that, we tried to make a user-friendly environment as most of the user's would-be farmers. There is a community for the users to discuss their problems and solutions with each other. There are necessary helplines contacts and real-time weather updates in the applications. There is also a cultivation plan for a weekly and monthly basis. So, it is a complete guideline to cultivate your crops from the very beginning.

5.2 Conclusions

Image Processing unbolted up a vast amount of research scope. Plant leaf and disease identification can be a gigantic feat for the agricultural sector if it reaches a maximum range of users. Particularly for those areas, where it takes so much time to reach for help. With this application, any user can detect and solve their respective problems on their own without waiting for reaching out to experts for treatment. The farming plan according to live weather updates can be really helpful to those people who fail to determine necessary steps in different conditions. The community of users will help the users to know new things. It has enormous possibilities in the future with proper nurturing.

5.3 Recommendations

Plant leaf and disease identification system has massive opportunities to contribute to different sectors rather than agriculture. It can be used in medical sectors to identify diseases that can be detected by analysing external parts of the human body. It can be used by a biologist to detect different kinds of species found in nature. It has a huge possibility to shine in educational sectors also.

5.4 Implication for Further Study

We are becoming increasingly dependent on modern technology to abridgment agricultural services and enhance the quality of life of the farmer. To continue with this propensity and to find new pathways for further modernization. In our proposed system we build up a way in which plant leaf disease can be easily identified and the required diagnosis will also available within a blink of an eye without wrecking valuable time and effort. In this session, we have already deployed the system in the Android platform and our posterior goal is to make it platform-independent. Having some dataset abridgment here we are unable to use higher-level CNN for the further study we are quested to collect thousands of data to ennoble our system stability and consistency. It is planned to integrate this system in the IoT devices so that farmers can get alert before a major attack of the disease happened. In the future by using some physical device like air moisture sensors, soil temperature sensors and water level intensity measuring sensors we will able to provide information about the health of plants so that the farmers can easily take the necessary steps to overcome the obstacles for achieving the best outturn. Above all, we are aimed to ennoble our country by bringing revolution in agriculture technology.

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APPENDIX

Appendix A: Research Reflection

Plant leaf and disease identification using image processing has always been in our matter of concern since the starting of final year. As none of our team members had any experience with image processing, we had to start from scratch. But by the grace of almighty and with the help of our dear supervisor, we have accomplished our goal. This research was harder than we thought as there are already several publications and mobile applications in the market. So, not only we had to do our research, but we also had to make sure that it is better than the existing systems. In the application, we tried to make a user-friendly environment for the users. But the missing features we found after analyzing all the existing mobile application in the market, was that all the application required an internet connection to analyze their contaminated leaf. So, the first priority of our project was to build a platform where the detection process can be done without any internet connection. Secondly, we wanted to build a community for the users where their problems and solutions can be shared by themselves and they will learn new things about cultivation from other users. One of the main features of our project was to suggest a monthly and a weekly cultivation plan according to the weather forecast. We provided with necessary contacts for emergency and regular treatment for diseased plants.

Appendix B: Related Issues

Though it was challenging to make a project about this particularly well-researched subject, it was an important lesson in our life. We had several crops field to collect necessary images to train our dataset. We are grateful the fellow researchers from Bangabandhu Sheikh Mujib Agricultural University, who helped us unconditionally whenever we needed. We also had help from our beloved classmates and teachers.

Finally, we want to develop and improve this project as this has a vast possibility to be the necessary application for all the farmers or any people who grow a plant of their own. We hope we will reach our desired destination very soon.

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