LYCHEE TREE DISEASE CLASSIFICATION AND PREDICTION USING DEEP LEARNING

BY

Sima Akter
ID: 182-15-11728

Md. Almas Ali
ID: 182-15-11733
AND

Md. Prince Mahmud
ID: 182-15-11736

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

Supervised By

Dr. Moushumi Zaman Bonny
Assistant Professor
Department of CSE
Daffodil International University

DAFFODIL INTERNATIONAL UNIVERSITY

DHAKA, BANGLADESH

SEPTEMBER 2022

APPROVAL

This Project/internship titled **"Lychee Tree Disease Classification and Prediction using Deep Learning"**, submitted by Sima Akter, ID No: 182-15-11728, Md. Almas Ali, ID No: 182-15-11733, and Md. Prince Mahmud, ID No: 182-15-11736 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 Bachelor of Science in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 14th September 2022.

BOARD OF EXAMINERS

Dr. Touhid Bhuiyan — **Chairman**
Professor and Head
Department of Computer Science and Engineering
Faculty of Science & Information Technology
Daffodil International University

Al Amin Biswas — **Internal Examiner**
Senior Lecturer
Department of Computer Science and Engineering
Faculty of Science & Information Technology
Daffodil International University

Mushfiqur Rahman — **Internal Examiner**
Senior Lecturer
Department of Computer Science and Engineering
Faculty of Science & Information Technology
Daffodil International University

Dr. Md Sazzadur Rahman — **External Examiner**
Associate Professor
Institute of Information Technology
Jahangirnagar University

DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Dr. Moushumi Zaman Bonny, Assistant Professor 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.

Supervised by:

17.09.22

Dr. Moushumi Zaman Bonny
Assistant Professor
Department of CSE
Daffodil International University

Submitted by:

Sima

Sima Akter
ID: 182-15-11728
Department of CSE
Daffodil International University

17.09.22

Md. Almas Ali
ID: 182-15-11733
Department of CSE
Daffodil International University

Md. Prince Mahmud

Md. Prince Mahmud
ID: 182-15-11736
Department of CSE
Daffodil International University

©Daffodil International University

ACKNOWLEDGEMENT

First we express our heartiest thanks and gratefulness to almighty God for His divine blessing makes us possible to complete the final year project/internship successfully.

We really grateful and wish our profound our indebtedness to **Dr. Moushumi Zaman Bonny, Assistant Professor**, Department of CSE Daffodil International University, Dhaka. Deep Knowledge & keen interest of our supervisor in the field of "*Image processing*" to carry out this project. Her endless patience ,scholarly guidance ,continual encouragement , constant and energetic supervision, constructive criticism, valuable advice ,reading many inferior draft and correcting them at all stage have made it possible to complete this project.

We would like to express our heartiest gratitude to **Dr. Moushumi Zaman Bonny**, and **Professor Dr. Touhid Bhuiyan**, Head**,** Department of CSE, for his kind help to finish our project and also to other faculty member and the staff of CSE department of Daffodil International University.

We would like to thank our entire course mate in Daffodil International University, who took part in this discuss while completing the course work.

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

ABSTRACT

Bangladesh is a predominantly agricultural nation. The majority of people depend on agriculture. But it is a sad fact that the quality and quantity of our fruits are declining due to numerous diseases. People in our nation are discovering numerous new unusual diseases in our native fruits, but we are failing to diagnose these diseases, and the severity of this issue is growing daily. So, to combat this issue, suitable treatment or recuperation is required. Since we live in a technological age, it goes without saying that technology may be quite helpful in identifying these ailments. As the health of a plant depends on its leaves, it is crucial to first identify any tree diseases. As a result, we can prevent illness from spreading to the tree and fruit. We are trying to identify tree and leaf diseases through our research. Research into lychee tree disease is something we are highly interested in. Therefore, by preventing sickness in our lychee fruit, we can contribute to the Bangladeshi economy. We use cutting-edge image processing methods that are very beneficial to us to guarantee the freshness of the leaves. By simply looking at the leaves, it is quite difficult to identify any disease. Our system uses a cutting-edge method called image processing. For this, we use the method CNN (Convolutional Neural Network) based transfer learning classification algorithm. In this, we use the VGG16, InceptionV3, and Xception algorithm and as a result, the Inception-V3 model beat the other two models with a maximum accuracy of 92.67%, which indicate the successful outcome of this study.

TABLE OF CONTENTS

CONTENTS	PAGE
Board of examiners	i.
Declaration	ii.
Acknowledgements	iii.
Abstract	iv.
CHAPTER	
CHAPTER 1: INTRODUCTION	**1-3**
1.1 Introduction	1
1.2 Motivation	1
1.3 Rationale of the Study	2
1.4 Research Questions	2
1.5 Expected Output	2
1.6 Report Layout	3
CHAPTER 2: BACKGROUND	**4-6**
2.1 Preliminaries/Terminologies	4
2.2 Related Works	4
2.3 Comparative Analysis and Summary	5
2.4 Challenges	5
CHAPTER 3: RESEARCH METHODOLOGY	**7-15**
3.1 Introduction	7
3.2 Research Subject and Instrumentation	7
3.3 Workflow	7
3.4 Data Collection Procedure	8

CONTENTS **PAGE**

CHAPTER 3: RESEARCH METHODOLOGY **7-15**

3.5 Statistical Analysis 11

3.6 Applied Methodology 12

CHAPTER 4: EXPERIMENTAL RESULTS AND DISCUSSION **16-21**

4.1 Experimental Setup 16

4.2 Experimental Results & Analysis 16

4.3 Discussion 21

CHAPTER 5: IMPACT ON SOCIETY, ENVIRONMENT AND SUSTAINABILITY **22-23**

5.1 Impact on Society 22

5.2 Ethical Aspects 22

5.3 Effect on Environment 22

5.4 Sustainability Plan 22

CHAPTER 6: CONCLUSION AND IMPLICATION FOR FUTURE RESEARCH 24

6.1 Conclusions 24

6.2 Future Work 24

REFERENCES **25-26**

APPENDIX **27**

LIST OF FIGURES

FIGURES	PAGE NO
Figure 3.1: Workflow diagram	8
Figure 3.2: Negative Leaf Necrosis	9
Figure 3.3: Negative Leaf Spot	9
Figure 3.4. Negative Stem Canker	10
Figure 3.5: Positive Fresh Leaf	10
Figure 3.6: Positive Stem Canker	11
Figure 3.7: Architecture Diagram of VGG-16	14
Figure 3.8: Architecture Diagram of Inception-V3	14
Figure 3.9: Architecture Diagram of Xception	15
Figure 4.1: VGG16 (epoch)	20
Figure 4.2: InceptionV3 (epoch)	20
Figure 4.3: Xception (epoch)	21

LIST OF TABLES

TABLES	PAGE NO
Table 4.1: Confusion matrix for VGG-16 algorithm	16
Table 4.2: Confusion matrix for Xception algorithm	17
Table 4.3: Confusion matrix for InceptionV3 algorithm	17
Table 4.4: Performance matrix for VGG-16 algorithm	18
Table 4.5: Performance matrix for Xception algorithm	18
Table 4.6: Performance matrix for InceptionV3 algorithm	19

CHAPTER 1
Introduction

1.1 Introduction

Popular tropical and subtropical fruit litchi, sometimes known as litchi, has sweet, juicy, and crunchy flesh. People adore litchi because of its distinct scent, delicious flavor, and nutritious worth [1]. We are all aware of Bangladesh's dependence on agriculture. Even we have a stake in this industry, either directly or indirectly. Despite being the eighth most populated nation in the world, almost 47% of our workforce works in the agriculture industry, which is crucial to our economy but is struggling in our nation. The agriculture industry accounts for 13% of the GDP, which is a significant portion [2]. A friendly farming industry is necessary for the lengthy security of food processors, and this can only be accomplished by upholding a useful, sustainable environment. Many seasonal fruits, including mango, jackfruit, litchi, papaya, guava, and others, are grown on around 79% of Bangladesh's agricultural land. One of them is lychee. May to July is when litchis are harvested. Currently, the full space beneath lychee cultivation is four, 800 hectares and the total annual production is regarding twelve, 800 MT. Bangladeshis might participate in the waiver after supplying their own requirements by gradually exporting food and agricultural products to other nations. In our nation, litchi is grown in the majority of square yards. We want to require the care of lychee to sustain our progress. In our analysis, we have a tendency to square measure operating to observe the lychee leaf and a few external diseases of lychee so that the lychee is unbroken and reasonably hassle-free and also the lychee diseases free. We tend to square measure by employing a trendy technology that belongs to deep learning with CNN algorithmic rule which might provide the expected outcome, this can show us. This method involves taking some pictures using a mobile device, uploading them to the system, and letting the system look for further keys. We get rules and these extrapolated features via CNN algorithms. Using real-life images, suggest a model for predicting the type of disease. Our suggested model complies with the CNN algorithm guidelines, enabling us to detect lychee disease with a fair degree of accuracy.

1.2 Motivation

Right now is an ideal opportunity of innovative transformation. Technology makes our life so much easier and better. When it comes to increasing financing, agriculture is vital everywhere, even in

our country of Bangladesh. Therefore, it's crucial for development to have a positive, practical environment. In order to guarantee long-term food security for humans, nearby agricultural buildings. Bangladesh is abundant in tropical and subtropical biodiversity. Notable organic products include mango, banana, jackfruit, pineapple, papaya, litchi, jujube, guava, and others. Mango, banana, and other tropical fruits make up 79% of the country's total harvested land. To visualize this case, we thought of determining a way to solve this downside. In this analysis, we try and apply the latest technology. So, we should solve this downside.

1.3 Rationale of the Study

Trees are the most significant and valuable resource in the ecosystem, as we well knows. But the demand for the total growth of trees is not fulfilled by its present ratio. Besides the growth are decreasing day by day and the farmers don't have proper knowledge of how to solve it. The existence of many rare plants is a threat already. Humans are more attracted to technologies nowadays than nature. Technologies can provide them with oxygen also. And chemicals are now a replacement for food or vitamins. For the increasing number of people all over the world, it is very tough to grow interested in trees and how to protect them. So it is high time to be concerned about the study of trees, plants, and leaves with help of technologies. Otherwise, we will get a generation without knowledge or concern for trees. But it is important for the existence of the balance of the environment. Through our study, anyone can know lychee trees and its plant's bad and good effects from the pictures. We take it as a wish that will grow some interest and help farmers to get their proper plants at least.

1.4 Research Questions

How do we classify and predict?

- Which algorithm is the best output score using the Deep learning algorithm?
- Among these three algorithms, which algorithm will give us better accuracy?
- Should we use a popular or new Deep learning technique?

1.5 Expected Output

- We can easily identify the disease and its solution.
- Improvement of the agriculture sector.

- Our farmers are capable of acting appropriately when necessary.
- Our growers may produce quality fruits.
- It is useful for unemployed people to join the agriculture sector.

1.6 Report Layout

There are six chapters in this research paper. They are Introduction, Background, Research Methodology, Working Procedure, Experimental Results and Discussion, Conclusion, and Future Research.

Chapter 1: Introduction; Introduction, Motivation, the rationale of the study, Research Questions, Objectives, Expected output, and Report Layout.

Chapter 2: Background; Terminologies, Related Works, Comparative, Analysis and Challenges.

Chapter 3: Research Methodology; Introduction, Research subject, and instrumentation, workflow, Data collection procedure, applied methodology and Implementation requirement.

Chapter 4: Working Procedure; Experimental setup, Experimental result and analysis, Discussion.

Chapter 5: Experimental Results and Discussion; Impact on Society, Impact on Environment, Ethical Aspects, Sustainability Plan.

Chapter 6: Conclusion; Conclusion and Further Work.

CHAPTER 2
Background Study

2.1 Terminologies

Many types of plants have different diseases. Similarly, this paper presents a process for detecting three types of diseases in a litchi plant. Here the data of two types of leaf diseases and one type of disease of tree branches are collected. By selecting images from the data, accuracy is determined through algorithms. Through this process, people will know about litchi leaf and pulse diseases. Then this can be solved properly and litchi production will increase.

In this chapter, we will try to learn more about these related works and challenges.

2.2 Related works

There are lots of papers on tree disease but very few papers on lychee tree disease. Here, are some research papers related to the work on lychee tree diseases.

Dubey. In this paper mainly, they found some reports of phytoplasma infection on fruit crops in India. They noticed necrosis and the rolling leaves of the litchi tree. In India, Deoria and Gorakhpur districts recorded 3% and 5% respectively. Attempts have been made to identify the etiology and characteristics of litchi disease in these districts and samples of three litchi-marked leaves and shoots were collected. The first and nested PCR testing using healthy litchi plant samples did not produce any amplification due to the usage of software such as Bayesian, AcaClone, and numerous other processes (data not shown) [3].

Wang. This paper is mainly, about how to maintain Litchi fruit senescence. We can measure the energy level by counting ATP. It is proven through different processes that senescence is deeply related to energy level, which can be ATP measurement. Therefore, here it is found that senescence of litchi fruit is disproportional to ATP [4].

Wang. In this study, they choose lychee to investigate surface quality. During harvest, the surface of the litchi shows scratches and fissures. They took 3743 samples from the data set and divided them into three categories. The most economical model, SSD-MobileNet V2, exhibits a

comparable MAP (91.81%) and a faster estimation speed (102 FPS), making it appropriate for real-time detection in industrial applications. Afterwards, several neural networks are studied [5].

Kumar. This paper is, on how to protect lychee from pests, extreme environmental conditions, and pesticide residues. Here, they have protected lychees through a bagging method. A physical protection method enhances the appearance of fruit by enhancing fruit color and minimizing flaws. The incidence of infections, insects, mechanical harm, sunburn, fruit breaking, pesticide residues, bird damage, etc. are all decreased by bagging fruit [6].

Rao. A group of students from India studied the small size of litchi leaves. This is because they are phytoplasma. Phytoplasma consists of different types of problems. It is a specific primary pair of rRNA, SecA gene, and phytoplasma. This phytoplasma is associated with about 700 plant diseases in the world. It belongs to the genus Molecule. It mainly lives in the tissues of Sieve tube plants of the infected class. Phytoplasma disease causes severe damage to fruit crops [7].

2.3 Comparative analysis and summary

This study dealt with three categories of litchi plant diseases, litchi leaf spot, litchi leaf necrosis, and stem canker. These three types of categories are applied in CNN, and CNN-based Transfer Learning classification algorithm. This means that we can analyze an image, identify the category under which the image falls and find out its accuracy.

2.4 Challenges

- Taking pictures while collecting data was very difficult because many of the pictures had to be found to find a diseased leaf.
- For data collection, we have taken pictures in a particular season because litchi plant disease is not seen in all seasons.
- Due to the pandemic, it was very difficult to go to the field and collect data.
- Due to a large size of the images, they were resized it took more time to find good software for resizing them.
- Had to change platforms due to seeing issues in the code.

- Due to the large number of images, processing takes time.
- Research papers on litchi plant diseases are scarce.
- At this point, we can claim that these tasks are difficult for us. Highly configured devices are necessary for the system.

CHAPTER 3
Research Methodology

3.1 Introduction

Here are a few deep image processing computer science algorithms to learn. For 2D classification, we choose CNN, and Transfer Learning. Layers are applied to images. Draw illustrations as we address the three illnesses affecting litchi plants. This technique for illness leaves may effectively categorize the photos, which will end the disease. Diagnose particular pre-harvest illnesses such as "Leaf Necrosis," "Leaf Spot," and "Stem Canker" using plant pictures and leaf samples. To learn more about this litchi sickness, we examined it. Several related studies on categorization and image processing have already, some insightful remarks have been made.

3.2 Research Subject and Instrumentation

Our research can provide a clear understanding of our subject field in this section. Working on the model application after deployment and design, ideal data gathering, and reliable data and model for training. We utilize the Windows platform to do our tasks. Python was employed to carry out our task. OpenCV, CSV, Sklearn, Keras, Numpy, and Tensor Flow are among the many library packages and programming languages that were utilized. Jupiter Notebook and virtual environments were employed. Because Python is a programming language, we choose it. Highly trustworthy for quick testing and deep learning of any application utilizing complicated algorithms. Without the virtual environment, we would have encountered many issues. About installing packages and libraries. To get around this issue, we worked on Google Colab entirely on our personal computers in a virtual environment on a nearby server.

3.3 Workflow

First, we collect data. Then after selecting some good and clear images from the data, the images are resized. We divide the categories of images into train set and test set, after all of that we have to train 80% data and 20% of the data will be used for test and getting accuracy based on algorithms.

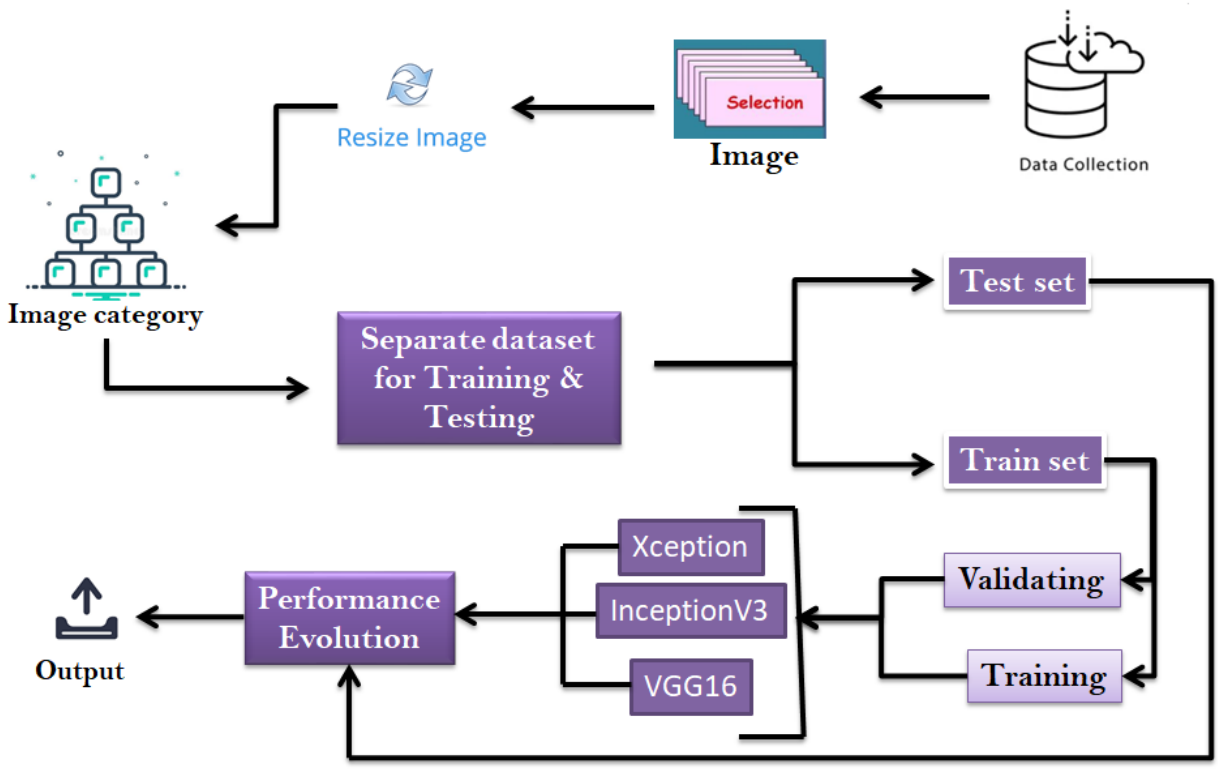

Figure 3.1: Workflow diagram.

3.4 Data Collection Procedure

Datasets play a crucial role in deep learning. No start time to conceptualize deep learning models, a dataset with real-world scenarios or events that need to be categorized must be gathered or created. Validate and train the model with success. For the suggested network training, we have created a new data set in our study. From our several location visits, we have gathered pictures of Lychee tree branches and foliage. Gram The resolution of each image varies, and they are all in JPG format. We have 1900 photos total in our data collection, three of which are pre-crop diseases including "Leaf Necrosis," "Leaf Spot," and "Stem Canker." 20% of the 1900 photos were used for testing, while 80% were used for training.

Figure 3.2: Negative Leaf Necrosis.

Figure 3.3: Negative Leaf Spot.

Figure 3.4 Negative Stem Canker.

Figure 3.5: Positive Fresh Leaf.

Figure 3.6: Positive Stem Canker.

3.5 Statistical Analysis

In this research work, we use 1900 primary data and plan to detect three pre-harvest lychee diseases of Leaf Necrosis, Leaf Spots, and Stem Canker along with a healthy class. We have allowed a .jpg image format in this research work. Here given below three ideal classes and their subclasses:

- Negative Leaf Necrosis
- Negative Leaf Spots
- Positive Fresh Leaf
- Negative Stem Canker
- Positive Stem Canker

1. Leaf Necrosis:

Colletotrichum gloeosporioides is the responsible organism (Class: Sordariomycetes). Colletotrichum gloeosporioides symptoms are linked to alternate mechanical injury and insect-

caused leaf lesions [8]. C. Cylindrical pink-colored conidia generated in gliosperioides acervuli are present in leaf necrosis. Managing actions avoid overhead irrigation because it exposes the spore region to a single water spray. Take out the grove's severely afflicted vegetation. Chlorothalonil, mancozeb, and copper-based fungicides can only be ineffective against the disease in extreme infestations.

2. Leaf Spots:

Responsible organism Homopsis species (Class: Sordariomycetes) Synonym Phomopsis species make branch notions appear in black (Alfiriat al. 1994). Older tree units are more prone to this illness [9]. Leaf Spot Caused by the fungus infectious agent Cephaleuros virescens. The symptoms embrace green to grey to rust red, watery, and on an irregular basis formed lesions on the foliage and new shoots of lychee trees. It may also infect branches and bark. Leaf spot is controlled simply by lime Sulphur sprays.

3. Stem Canker:

Harmful organisms Species of Botryosphaeria (Class: Dothideomycetes) Symptoms Botryosphaeriaspp. Typically, edible fruits attack plant terminal branches (Alfieriaet al. 1994). This plant enters through the plant's injured surface and through branches that are dead or dying [10]. Sunken, shriveled, crooked, and dead tissue on the stem is a hallmark of the disease. Stem Canker Caused by the infectious agent Botryosphaeria sp., little potato typically attacks the terminal branches of edible fruit trees. It causes oval or irregularly formed, sunken lesions on the branches, which can cause the bark to crack open. Preventative flora applications will facilitate managing the illness and infected branches are cropped out, however, make certain to sterilize your pruners.

3.6 Applied Methodology

In our methodology, we applied a Convolutional neural network (CNN) based transfer learning algorithm. We applied three transfer learning; which are VGG-16, Xception, and Inception-V3. The relevant theory of Convolutional neural network (CNN) in terms of transfer learning is explained precisely in below.

3.6.1 Convolutional Neural Networks (CNN):

Convolutional neural network (CNN), a category of artificial neural networks that have become dominant in varied laptop vision tasks, is attracting interest across a range of domains, together with radiology [11]. A Convolutional neural network consists of multiple building blocks, like convolution layers, pooling layers, and connected layers, and is intended to mechanically and adaptively learn abstraction hierarchies of options through a back propagation algorithmic program. CNN algorithmic program relies on varied modules that are structured in an exceedingly specific advancement that are listed as follows:

- Input Image
- Convolution Layer (Kernel)
- Pooling Layer
- Classification — Fully Connected Layer
- Architectures

3.6.2 VGG-16:

A sort of artificial neural network is a convolutional neural network, commonly referred to as a convolutional network. An input layer, an output layer, and some hidden layers make up a convolutional neural network [12]. The CNN (Convolutional Neural Network) variant known as VGG16 is one of the top computer vision models available today. One of the well-known models submitted to ILSVRC-2014 is this one. VGG16 is object identification and classification method that has a 92.7% accuracy rate when categorizing 1000 photos into 1000 distinct categories. It is a well-liked technique for classifying images and is simple to apply with transfer learning.

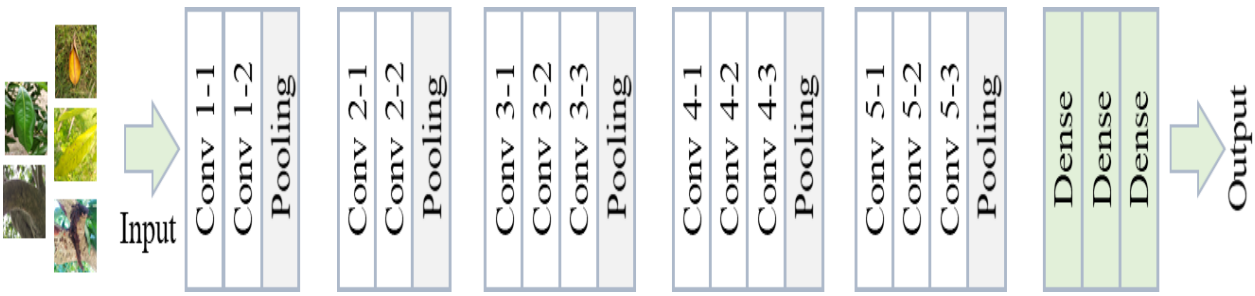

Figure 3.7: Architecture Diagram of VGG-16.

3.6.3 Inception-V3:

An image model block called an inception module seeks to simulate an ideal local sparse structure in a CNN. To put it simply, it enables us to employ many filter shapes in a single picture block as opposed to only one filter shape, which we then combine and pass to the following layer [13]. A CNN's inception module is an image model block that tries to get close to an ideal local sparse structure. Simply said, it enables us to utilize a variety of filter shapes in a single picture block as opposed to being restricted to just one filter shape, which we then combine and pass to the following layer.

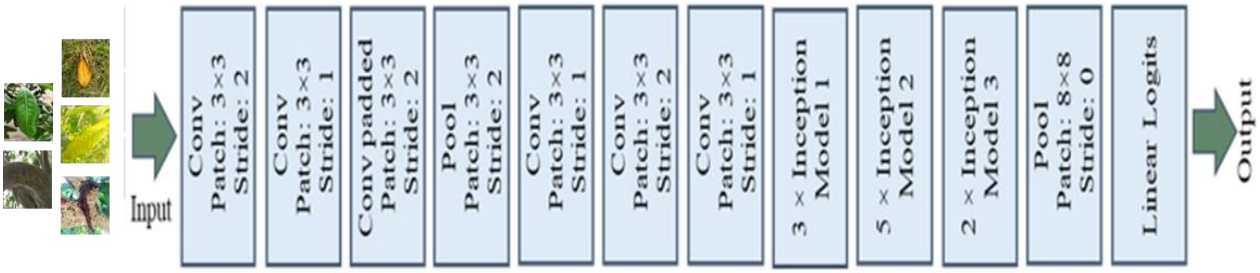

Figure 3.8: Architecture Diagram of Inception-V3.

3.6.4 Xception:

A deep convolutional neural network design with depth-wise separable convolutions is an xception. Francois Cholet, who created Google, Inc., also founded this network (Fun-Fact: He is the creator of Keras) [14]. The "extreme" form of an Inception module is referred to as Xception. A convolutional neural network with 71 layers is called Xception. From the ImageNet database, we may load a network that has been trained using more than a million photos. The pre-trained network can categorize photos into thousands of item categories, including various animals, keyboards, mice, and pencils. The network learns detailed feature representations for larger pictures consequently. The size of the network's picture input is 299 by 299 pixels. Utilizing the Xception paradigm, we can utilize classify to categorize fresh photos.

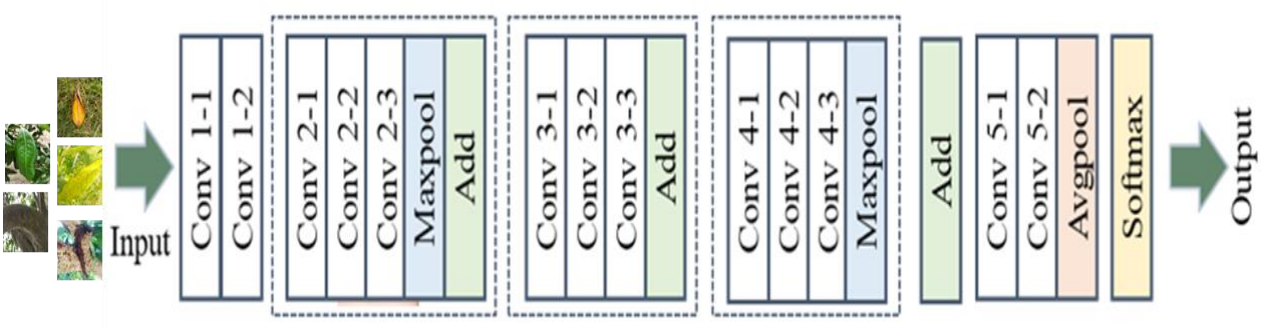

Figure 3.9: Architecture Diagram of Xception.

3.7 Performance Measurement

After training the models, we utilized test data to estimate their performance. The metrics that were calculated for performance evaluation are listed below. We identified the model that could predict the outcome best using these parameters. Many percentage performance metrics have been generated using Eqs. (1-7) based on the confusion matrix provided by the model.

$$Accuracy = \frac{True\ Positive + TrueNegative}{Total\ Number\ of\ image} \times 100\% \quad (1)$$

$$True\ Positive\ Rate\ (TPR)\ or\ Recall = \frac{True\ Positve}{True\ Positive + False\ Negative} \times 100\% \quad (2)$$

$$True\ Negative\ Rate\ (TNR) = \frac{True\ Negative}{False\ Positive + True\ Negative} \times 100\% \quad (3)$$

$$False\ Positive\ Rate\ (FPR) = \frac{False\ Positive}{False\ Positive + True\ Negative} \times 100\% \quad (4)$$

$$False\ Negative\ Rate\ (FNR) = \frac{False\ Negative}{False\ Negative + True\ Positive} \times 100\% \quad (5)$$

$$Precision = \frac{True\ Positive}{True\ Positive + False\ Positive} \times 100\% \quad (6)$$

$$F1\ Score = 2 \times \frac{Precision \times Recall}{Precision + Recall} \times 100\% \quad (7)$$

CHAPTER 4

Experimental Result and Discussion

4.1 Experimental Setup

Our experimental setup has gathered huge knowledge about algorithms in different languages. First, we collect 1900 images from litchi orchards. We can use more data if we want because the more data we use the more accurate our experiment results will be. To classify more accurate images, we have set 20% of the collected data of this research as a test set and 80% as the training set. After various research papers, we have taken up the concept of various diseases of the lychee plant. But we identified 3 diseases of a lychee tree. (1) Leaf necrosis, (2) Leaf spot, and (3) Stem canker. But we have done 5 classes as like Negative Leaf necrosis, Negative Leaf spot, Negative Stem canker, Positive Fresh Leaf, and Positive Stem Canker. We collected 343 images for leaf necrosis disease, 260 for leaf spot disease, and 313 images for stem canker disease and we collected 622 fresh leaf and 362 images of stem canker for healthy plants. We selected 1250 images for training and 400 images for testing. This is how the data is set.

4.2 Experimental Results & Analysis

4.2.1 Confusion Matrix:

Here is the Confusion matrix of the VGG-16 algorithm. In this model the maximum value of TP is Positive Stem Canker 180, TN is Negative Stem Canker 147 similarly the minimum value of FN is Negative Stem Canker 8 and FP is Negative Leaf Necrosis 5.

Table 4.1: Confusion matrix for VGG-16 algorithm.

Model	Class	TP	FN	FP	TN
VGG-16	Positive Stem Canker	180	15	13	142
	Positive Fresh Leaf	173	33	6	138
	Negative Stem Canker	179	8	16	147
	Negative Leaf Spots	168	26	22	134
	Negative Leaf Necrosis	173	29	5	143

The Confusion matrix of the Xception algorithm. In this model the maximum value of TP is Positive Stem Canker 187, TN is Negative Stem Canker 144 similarly the minimum value of FN is Positive Stem Canker 10 and FP is Negative Leaf Necrosis and Positive Fresh Leaf 14.

Table 4.2: Confusion matrix for Xception algorithm.

Model	Class	TP	FN	FP	TN
Xception	Positive Stem Canker	187	10	23	130
	Positive Fresh Leaf	183	17	14	136
	Negative Stem Canker	166	19	21	144
	Negative Leaf Spots	153	37	23	137
	Negative Leaf Necrosis	181	23	14	132

The Confusion matrix of the InceptionV3 algorithm. In this model the maximum value of TP is Negative Leaf Necrosis 204, TN is Negative Leaf Spots 149 similarly the minimum value of FN is Negative Leaf Spots 2 and FP is Negative Leaf Spots 1.

Table 4.3: Confusion matrix for InceptionV3 algorithm.

Model	Class	TP	FN	FP	TN
InceptionV3	Positive Stem Canker	191	9	12	138
	Positive Fresh Leaf	176	10	19	145
	Negative Stem Canker	182	21	34	114
	Negative Leaf Spots	198	2	1	149
	Negative Leaf Necrosis	204	5	2	139

4.2.2 Performance Matrices:

Performance matrix for VGG-16 algorithm. In this model, the maximum accuracy is Negative Stem Canker 93.14% and the maximum precision is Negative Leaf Necrosis 97.19%

Table 4.4: Performance matrix for VGG-16 algorithm.

Model	Class	Accuracy	TPR	FNR	FPR	TNR	Precision	F1 Score
VGG-16	Positive Stem Canker	92.00	92.31	7.69	8.39	91.61	93.26	92.78
	Positive Fresh Leaf	88.86	83.98	16.02	4.17	95.83	96.65	89.87
	Negative Stem Canker	93.14	95.72	4.28	9.82	90.18	91.79	93.72
	Negative Leaf Spots	86.29	86.60	13.40	14.10	85.90	88.42	87.50
	Negative Leaf Necrosis	90.29	85.64	14.36	3.38	96.62	97.19	91.05

Performance matrix for Xception algorithm. In this model, the maximum accuracy is Positive Fresh Leaf 91.14% and the maximum precision is Positive Fresh Leaf 92.89%

Table 4.5: Performance matrix for Xception algorithm.

Model	Class	Accuracy	TPR	FNR	FPR	TNR	Precision	F1 Score
Xception	Positive Stem Canker	90.57	94.92	5.08	15.03	84.97	89.05	91.89
	Positive Fresh Leaf	91.14	91.50	8.50	9.33	90.67	92.89	92.19
	Negative Stem Canker	88.57	89.73	10.27	12.73	87.27	88.77	89.25
	Negative Leaf Spots	82.86	80.53	19.47	14.38	85.63	86.93	83.61
	Negative Leaf Necrosis	89.43	88.73	11.27	9.59	90.41	92.82	90.73

Performance matrix for Inception -V3 algorithm. In this model, the maximum accuracy is Negative Leaf Spot 99.14% and the maximum precision is Positive Fresh Leaf 99.50%

Table 4.6: Performance matrix for InceptionV3 algorithm.

Model	Class	Accuracy	TPR	FNR	FPR	TNR	Precision	F1 Score
InceptionV3	Positive Stem Canker	94.00	95.50	4.50	8.00	92.00	94.09	94.79
	Positive Fresh Leaf	91.71	94.62	5.38	11.59	88.41	90.26	92.39
	Negative Stem Canker	84.57	89.66	10.34	22.97	77.03	84.26	86.87
	Negative Leaf Spots	99.14	99.00	1.00	0.67	99.33	99.50	99.25
	Negative Leaf Necrosis	98.00	97.61	2.39	1.42	98.58	99.03	98.31

4.2.2 Accuracy graph

We have used three algorithms. In addition, the best accuracy rate has come from InceptionV3.

- In model accuracy:

  Validation and training loss plots decrease to a point and increase again.

- In model loss:

  Training and validation loss plots decrease with experience.

The accuracy and loss of the model are shown through the graph.

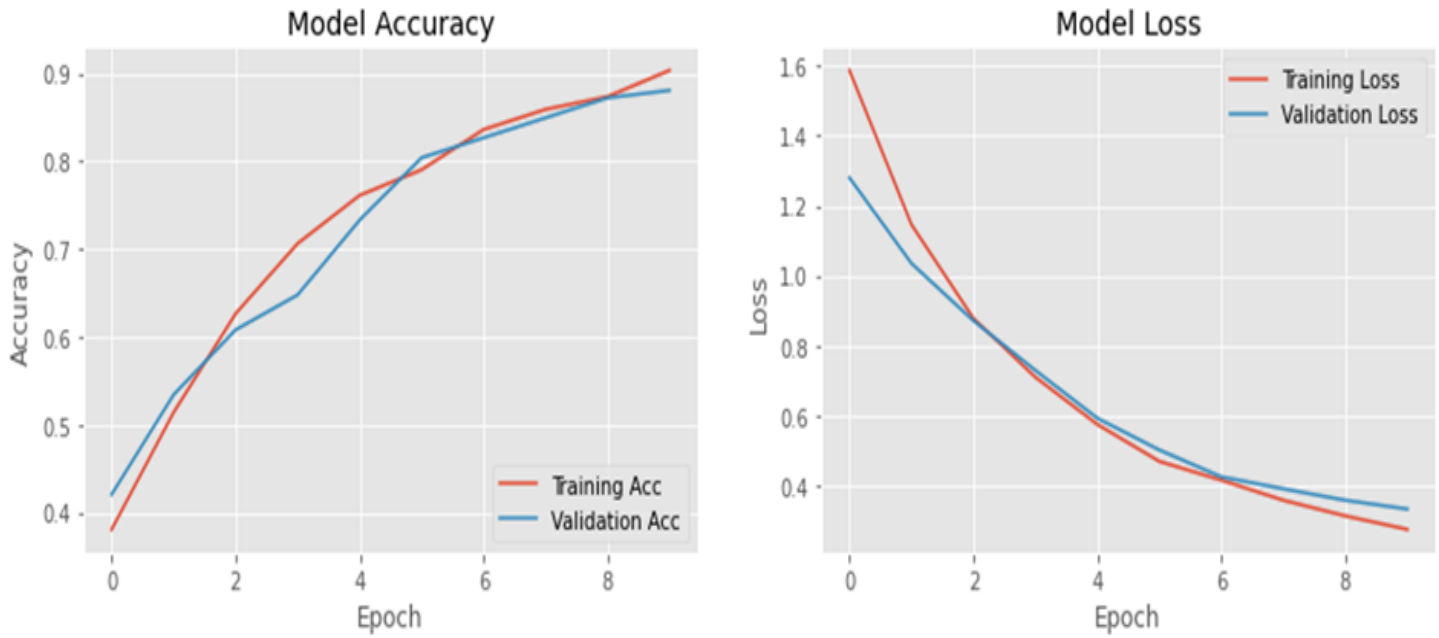

Figure 4.1: VGG16 (epoch)

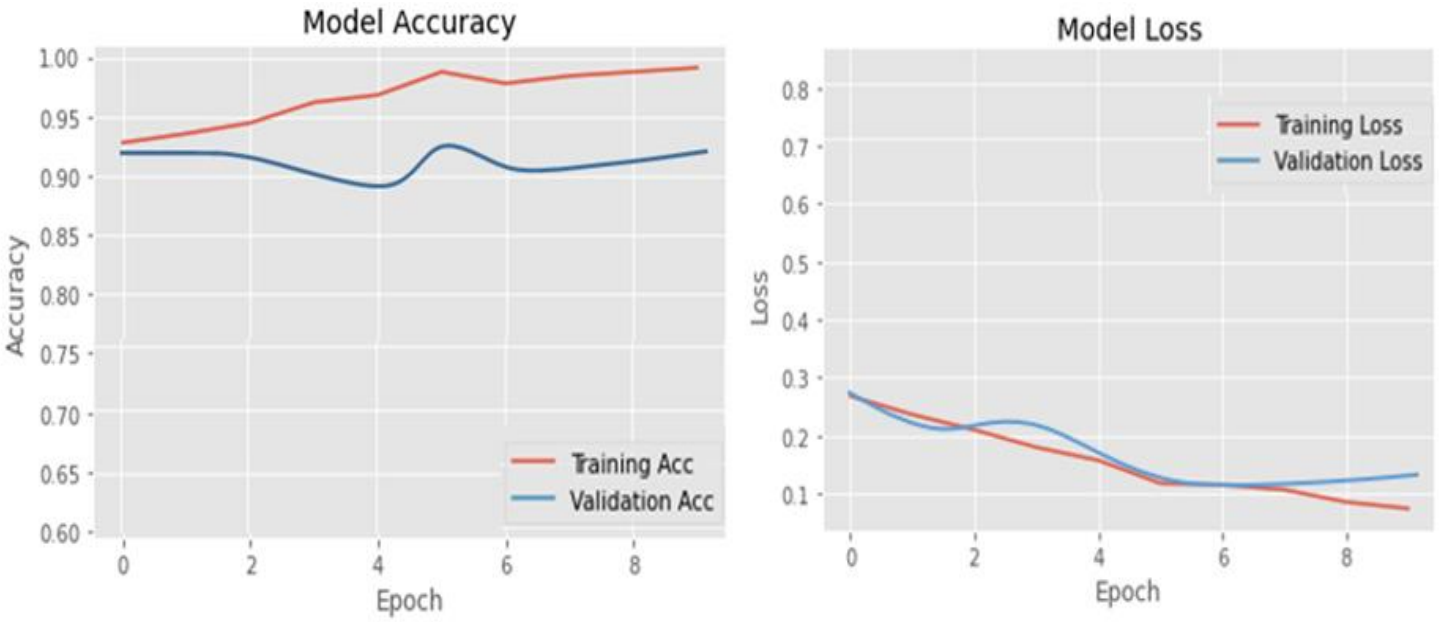

Figure 4.2: InceptionV3 (epoch)

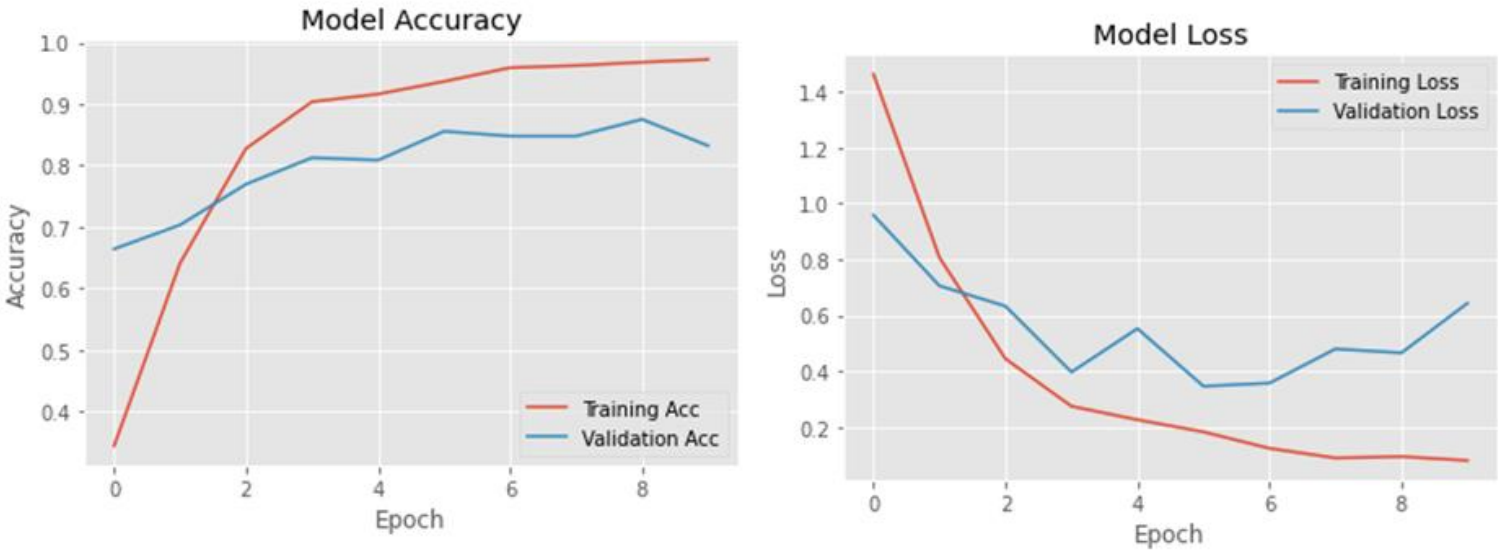

Figure 4.3: Xception (epoch)

4.3 Discussion

Identification is a very important step for crops. If the disease is not diagnosed at the right time, one has to face many losses. With the development of modern strategies and technology, farmers will be able to diagnose this disease at the right time and reduce the amount of damage [15]. Therefore, we have tried to find a diagnosis method using VGG16, InceptionV3, and Xception algorithm to diagnose litchi leaves to solve this problem. We took deep knowledge of CNN and found the results of this research to be accurate. InceptionV3 has given very good results, which we have shown, through numerical and graphical classification. These values accurately expressed the vision of our research, which will be very useful for future research.

©Daffodil International University

CHAPTER 5

Impact on Society, Environment and Sustainability

5.1 Impact on society

Leaf disease is a huge challenge to society because it affects the growth of plants and the production of the crop. It hampers nature's gracefulness by damaging plants around homes, parks, or any other roads [16]. It is one of the main causes of having less food available for humans because it hugely interferes with crop yields. This is a huge reason for human starvation and dying hunger.

5.2 Ethical aspects

Most developed countries can grow more foods because their technologies are very improved and give high-level accuracy to detect leaf disease on the plant. We wanted to do this because in our country the farmers are losing huge crop yields because of not having expert technology [17]. We have done this to help the farmers and help them to grow more crops. So that people in our country have enough food and they don't die from hunger.

5.3 Effect on environment

We as human beings need a healthy environment to lead a healthy life. For a prosperous life, we need to eat good food. Our research work will help the environment to grow more food because it will detect the leaf in the early stage, early disease detection means a higher chance to save the plant. And by saving the plant it will automatically grow more food [18]. The less infection the fewer environments have bigger problems. We can produce more food through early leaf disease detection.

5.4 Sustainability Plan

This research work will be one of the most unique and convenient works as we have made this work by keeping in mind the farmers and their struggles [19]. It will immensely help them and

©Daffodil International University

will do a lot of wonders for them. We have done this work by taking images as the input data. It has the potential to distinguish the leaf necrosis, leaf spot, and stem canker of the leaf. It will give a very great accuracy, which will help us in a greater form.

©Daffodil International University

CHAPTER 6

Summary, Conclusion, Recommendation and Implication for Future Research

6.1 Conclusion

This research primarily focuses on applying deep learning to detect diseases from leaf and Tree branches. We used CNN algorithm. There are numerous CNN models to choose from. However, we discovered that VGG16, Exception, and Inception performed well in our dataset with a high level of accuracy. With an accuracy of 92.67%, InceptionV3 is performing admirably compared to VGG16 89.62% and Xception at 88.86%. Despite the limited quantity of data we have, we have made every effort to obtain the best results. These efforts have a great deal of promise to help Bangladesh's agricultural industry. Most farmers in Bangladesh lack information and are not aware of the appropriate approaches for disease identification and treatment. Farmers are suffering as a result of the crops' daily, slow degradation. As a result of this work, the position of Bangladeshi farmers may significantly change.

6.2 Future work

During our work, we apply the deep learning-based algorithm, and a high identification rate for diseases is found. We used our initial dataset to test our method [20]. This technique can be applied to more datasets, or it can be applied to this dataset using other deep learning approaches. Furthermore, it will be possible to utilize various methods to enhance it. Therefore, anyone can use our methods to optimize their related works and support farmers. Our target was to use more classes. We wanted to work on the disease of litchi besides the leaf tree branch of litchi. But it was not possible due to the lack of litchi season. If anyone wants to work on the disease of litchi in the future, then they can do it.

©Daffodil International University

REFERENCES

[1] Yang, Yi-Chao, Da-Wen Sun, and Nan-Nan Wang. "Rapid detection of browning levels of lychee pericarp as affected by moisture contents using hyperspectral imaging." Computers and Electronics in Agriculture 113 (2015): 203-212.

[2] Haque, Md, Md Alim, and Md Alam. "Litchi Leaf Disease Recognition by Using Image Processing." (2021).

[3] Rao, Govind P., Ajay K. Tiwari, and Durgesh Dubey. "Identification and characterization of two phytoplasma subgroups (16SrXI-D and 16SrXIV-A) associated with lychee (Litchi chinensis Sonn) in India." *Journal of Plant Diseases and Protection* 124.3 (2017): 235-239.

[4] Wang, Hui, et al. "Energy status of ripening and postharvest senescent fruit of litchi (Litchi chinensis Sonn.)." *BMC plant biology* 13.1 (2013): 1-16.

[5] Wang, Chenglong, and Zhifeng Xiao. "Lychee surface defect detection based on deep convolutional neural networks with GAN-based data augmentation." *Agronomy* 11.8 (2021): 1500.

[6] Purbey, S. K., and Amrendra Kumar. "Effect of pre-harvest bagging on quality and yield of litchi (Litchi chinensis Sonn.) fruits." *The Ecoscan* 7 (2015): 197-201.

[7] Rao, Govind Pratap, et al. "Identification of phytoplasma in six fruit crops in India." *European journal of plant pathology* 156.4 (2020): 1197-1206.

[8] Haque, Md, Md Alim, and Md Alam. "Litchi Leaf Disease Recognition by Using Image Processing." (2021).

[9] Hasna, Shornaly Akter, and Narayan Ranjan Chakraborty. "Automatic Recognition of Plant Leaf Diseases Using Deep Learning (Multilayer CNN) and Image Processing." *Third International Conference on Image Processing and Capsule Networks: ICIPCN 2022*. Vol. 514. Springer Nature, 2022.

[10] 2 Zihad, Mozahid Md, et al. "A Convolution Neural Network Based Approach for Detection of Tree from Leaf Images." (2019).

[11] 4 Koul, Bhupendra, and Pooja Taak. "Lychee (Litchi chinensis Sonn.): Pre-and Post-harvest Disease Management." Lychee Disease Management. Springer, Singapore, 2017. 1-26.

[12] Mo, Jiawei, et al. "Deep learning-based instance segmentation method of litchi canopy from UAV-acquired images." Remote Sensing 13.19 (2021): 3919.

©Daffodil International University

[13] Wang, Hongjun, et al. "YOLOv3-Litchi detection method of densely distributed litchi in large vision scenes." *Mathematical Problems in Engineering* 2021 (2021).

[14] Liang, Cuixiao, et al. "A visual detection method for nighttime litchi fruits and fruiting stems." Computers and Electronics in Agriculture 169 (2020): 105192.

[15] Gao, Peng, et al. "Modeling for the Prediction of Soil Moisture in Litchi Orchard with Deep Long Short-Term Memory." Agriculture 12.1 (2021): 25.

[16] Peng, Hongxing, et al. "Litchi detection in the field using an improved YOLOv3 model." International Journal of Agricultural and Biological Engineering 15.2 (2022): 211-220.

[17] Kalwad, Priyadarshini D., et al. "Apple Leaf Disease Detection and Analysis Using Deep Learning Technique." Information and Communication Technology for Competitive Strategies (ICTCS 2020). Springer, Singapore, 2022. 803-814.

[18] Rao, Govind P., Ajay K. Tiwari, and Durgesh Dubey. "Identification and characterization of two phytoplasma subgroups (16SrXI-D and 16SrXIV-A) associated with lychee (Litchi chinensis Sonn) in India." Journal of Plant Diseases and Protection 124.3 (2017): 235-239.

[19] Kong, Guanghui, et al. "The basic leucine zipper transcription factor PlBZP32 associated with the oxidative stress response is critical for pathogenicity of the lychee downy blight oomycete Peronophythora litchii." Msphere 5.3 (2020): e00261-20.

[20] Kumar, Vinod, Ajit Kumar Dubedi Anal, and Vishal Nath. "Prevalence of some threatening pests and disease of litchi (Litchi chinensis Sonn.) in Bihar state of India." Journal of Applied Horticulture 16.3 (2014).

©Daffodil International University

Appendix

A1. Sample Dataset of Lychee Tree and Leaf

©Daffodil International University

Lychee Tree Disease Classification and Prediction Using Deep Learning

ORIGINALITY REPORT

25%	22%	10%	16%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	dspace.daffodilvarsity.edu.bd:8080 Internet Source	11%
2	Submitted to Daffodil International University Student Paper	3%
3	onlinelibrary.wiley.com Internet Source	1%
4	www.mdpi.com Internet Source	1%
5	Meghna Srivastava, John M. Howard, Tao Gong, Mariama Rebello Sousa Dias, Marina S. Leite. "Machine Learning Roadmap for Perovskite Photovoltaics", The Journal of Physical Chemistry Letters, 2021 Publication	1%
6	Submitted to Bournemouth University Student Paper	1%
7	cyberleninka.org Internet Source	1%

©Daffodil International University