DISEASE IDENTIFICATION IN MANGO LEAF USING IMAGE PROCESSING

BY

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FINAL YEAR DESIGN PROJECT REPORT

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

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APPROVAL

This Project titled **"Disease Identification in Mango Leaf Using Image Processing"**, submitted by MD. Nurun Nabi (ID: 201-15-14349) 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.

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DECLARATION

I hereby declare that, this project has been done by me under the supervision of **Deawan Rakin Ahamed Remal, Lecturer, Department of CSE** Daffodil International University. I 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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ABSTRACT

The king of fruits, the mango is in great demand, thus it is imperative to prevent sickness in order to maximize profits. Because symptoms can vary, automatic segmentation and detection of leaf diseases remains difficult. For any computer-aided method to identify leaf diseases in mango plants, accurate segmentation of the illness is a critical requirement. I suggested using a CNN model to partition the mango leaf's sick area in order to address this problem. The suggested CNN uses certain preprocessing methods before learning the characteristics of each pixel in the input data directly. Using the real-time dataset provided by the Bangladeshi mango research, we assessed the suggested CNN. I compared the segmentation performance of the suggested model results to that of the state-of-the-art models that are currently available, such as Vgg16, resnet50, denseNet, efficientNet, InceptionV3, and mobileNet. Moreover, the segmentation accuracy of the suggested model training is 99.46%, significantly greater than that of the other models. We have determined that by utilizing a CNN, the input image might learn more distinct and focused features, leading to an enhanced recognition performance and the identification of disorders. As a result, I also make a web application. given that most individuals in our country know how to use an Android feature phone. I write a simple software. Here, all the user needs to do is snap a photo of an mango leaf, and my algorithm will tell you whether it's healthy or not.

Keywords: mango leaf disease identification, deep learning, CNN, VGG16, MobileNet, InceptionV3, EfficientNetB0, DenseNet121, ResNet50.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Mango (Mangifera indica) is a prominent and economically significant fruit crop in Bangladesh, contributing substantially to both domestic consumption and export. However, the sustainable cultivation of mango faces challenges posed by various diseases that affect the health and yield of mango trees. Among these, the early identification of diseases in mango leaves is crucial for implementing timely and effective management strategies. Traditionally, disease identification in crops has relied on visual inspections by experienced agronomists. While this approach has been valuable, it is labor-intensive, time-consuming, and may not always provide timely detection, leading to potential yield losses. In recent years, technological advancements in image processing and computer vision have offered promising alternatives for the rapid and accurate identification of crop diseases.

The aim of this research is to explore the application of image processing techniques in the identification of diseases affecting mango leaves. By leveraging digital imagery, this study seeks to develop an efficient and automated system that can detect and classify common mango leaf diseases. This not only addresses the limitations of manual inspection but also provides an early warning system for farmers, enabling timely intervention to mitigate the impact of diseases on mango orchards.

The significance of this study lies in its potential to revolutionize mango disease management practices in Bangladesh. A robust and automated system for disease identification in mango leaves would empower farmers with a rapid and reliable tool, enabling them to take preventive measures and optimize treatment strategies. Timely detection can minimize the economic losses associated with crop diseases, enhance overall productivity, and contribute to the sustainable cultivation of mango orchards. Moreover, the outcomes of this research may have broader implications for the field of agricultural technology and image processing applications. By addressing a specific agricultural challenge, this study aligns with the global effort to harness technology for sustainable and efficient farming practices.

1.2 Objective

I cannot exist without technology because it makes it easier for us to adapt to the always shifting circumstances in our lives. Our daily lives and this technology era are inextricably linked. My main objective was to distinguish between healthy and unhealthy mango leaves. In my investigation, I made use of several varieties of leaves.

To make our research easier to use, I have converted our study into an Android application. My goal is to use deep learning to distinguish between healthy and diseased mango leaves. So, the following is a list of my goals.

While there are a lot of other topics to look at, I will just look into those that are relevant to our papers. Sorting every mango leaf into groups for healthy and sick leaves is my aim. It is nearly hard to distinguish healthy leaves from unhealthy ones on mango leaves these days. Humans that do this hard activity grow bored after performing a task repeatedly, machines, on the other hand, never get bored.

I use this kind of technology because of this, and a platform has been developed so that I can use deep learning to distinguish between healthy and unhealthy leaves. For convenience of use, I created a web application. Here, the user simply takes a picture, after which my research technique substantiate.

1.3 Motivation

Mango is a typical and common fruit. These are purchased from the market, because it plays a crucial role in many of the vitamins in our nutritious diet. Unfortunately, because to time constraints, I unable to identify whether the fruit leaves are healthy or infected. Sometimes, if I have the time, I am not aware of the benefits. Thus, whether on purpose or by accident, several fruit leaves can become sick every day. These discarded leaves are not only a waste of money, but they also injure the fruits. The cost of goods in Bangladesh is currently so high that throwing away food and fruits is regarded as a luxury. For this reason, I considering setting up to reduce costs and prevent leaf disease.

1.4 Rationale of the Study

Nowadays, AI is employed extensively. Since artificial intelligence has already revolutionized a number of professions. These days, artificial intelligence can overcome any obstacle. From the standpoint of our science and technology, it's definitely a bigger stage. For picture data, convolutional neural networks are helpful. CNN also referred to as an image analyzer because of this. It can be used in many domains to address a range of problems, such as locating cancer cells or diagnosing disease in plants. In the end, we believe it helps us overcome our own challenges. Furthermore, my analysis reveals that CNN application performs optimally when a state-of-the-art tensor flow module is utilized. AI is a widely used field these days, and I all well aware of how hard it is to categorize.

1.5 Expected Output

The benefits of using AI to recognize leaves are numerous and should be anticipated. Below are a handful of them:

Objectives Develop a reliable model that can determine if leaves are healthy or diseased.

• Assist kids in learning how to recognize unhealthy mango leaves.

• Facilitate the identification of healthy or sick leaves.

• Assist in saving people's precious time.

1.6 Research Questions

Since this is my first professional project that I just starting to finish, the work is quite tough for me. The following is a list of the primary topics this research focuses on.

• Is it possible to tell whether the mango leaves in the above image are healthy or sick?

What are the limitations of AI in terms of determining healthy or unhealthy leaves?

• Can the project distinguish between a large number of healthy and unhealthy mango leaves in a single image?

• Specifically, who will gain from our research?

1.7 Project Management and Finance

As of right now, I'm managing the project alone, which keeps things simple. As I'm training and developing the models with the resources at my disposal, I haven't yet encountered any significant financial difficulties. Developing the system has only been me, thus project management has been fairly easy.

Looking ahead, I am aware that the system may become more expensive and complex if I need to modify it to accommodate various device kinds. It's possible that these adjustments will cost more money and resources.

In the event that the project reaches a stage where more cash is required, particularly for these device-specific adjustments, I will investigate my options for obtaining assistance from suitable funding authorities or sources. It will be crucial to complete this step in order to ensure that the project may expand and meet new technical needs.

1.8 Layout of the Report

Bangladesh is an agricultural nation, which is the foundation of my research proposal. In Bengali cuisine, fruits are highly regarded. This work aids in differentiating between sick and fresh mango leaves.

In Chapter 1, I've already covered the introduction of the study articles, their goal, my motivation for working on this topic and selecting these specific mango leaves, issue statements, anticipated outcomes, research questions, and research techniques.

In chapter 2, I will discuss the study's background as well as the necessary activities to finish in order to write this essay. This section is devoted to summarizing our study. In addition, I discuss the challenges I faced in completing our assignment successfully and compare my conclusions to the ideas I chose.

In chapter 3, This study's methodology is given. In this section, we'll rapidly go over our entire coding process with the aid of a suitable picture and table.

In chapter 4, The results and analysis of the experiment are discussed. Multiple research and testing models will be used.

Chapter 5 is all about Summary, comparison and analysis, Advantage of our application are covered.

Chapter 6 is all about conclusion and future research.

CHAPTER 2
BACKGROUND

2.1 Introduction

Actually, this section discusses our previous work. since the work we are doing now is derived from earlier work. There are a lot of things from the earlier work that we may draw inspiration from to create something fresh. This part examines our linked work concept and provides an explanation of our actual scenario. I will discuss our experience with this project here because we found it to be sufficiently demanding. I go into great length about our benefits and usefulness as well. Robust approach plan, along with the way I accomplished this objective without a hitch and with the intention of enhancing performance, and clarify how we arrived at this degree of precision.

2.2 Related Works

Deep learning applications have transformed a number of industries, including healthcare and agriculture. Many ongoing thesis projects in deep learning are underway. The author categorized Machine Learning based Classification of Diseased Mango Leaves from the perspective of Bangladesh [1]. Though it takes time and is subjective, humans are able to sort and detect. To ensure their market value and freshness, a professional leaf sorting method is needed. An accurate, egalitarian, and non-destructive computer vision method is used to grade mango leaves. Author formerly The four main steps in a computer vision-based assessment are acquisition, segmentation, feature extraction, and classification [8]. Sorting through many leaf species is a challenging undertaking. In this study, a method for differentiating between two types of leaves and assessing their quality is described. In-depth learning was used by the author to examine the detection of mango leaf disease [2]. The Convolutional Neural Network (CNN) is utilized to extract leaves from the input data. When it comes to efficacy, the author’s proposed approach outperforms both cutting-edge techniques and transfer learning methodology [3]. CNN approaches for disease classification focus on hand-crafted, weak, and uncomplicated characteristics. Author affirms the superiority of our suggested paradigm [4]. Though they need a large number of samples, sophisticated artificial algorithms like CNNs have emerged as a viable way to obtain improved accuracy. The overall quality of a leaf is determined by its external characteristics, including its color, volume, form, structure, and presence of damage. investigated mango leaf damage to show various techniques for feature extraction for the creation of probabilistic neural network (PNN) forecasts. [5]. The purpose of this project is to determine the freshness of a mango leaf using CNN. CNN Detection and Maturity Status Classification were employed by the author [6]. We were able to obtain 97.92% accuracy by attempting to recognize leaves using Resnet 50 and classifying them using the suggested architecture.

The system has the ability to sort the leaves. It can be used to check on the condition of the leaves. In a farmer's self-service system, it can be used to categorize leaves. The system uses the 'ImageNet' dataset, which is of excellent quality. It contains two distinct types of leaf graphics. The model uses CNN to identify leaves in pictures. The accuracy was discovered to be 92.23%. Machine learning approaches are far less effective than deep learning methods. [7]. The conventional approach is prone to environmental changes, uneven results, and inconveniences. The results indicate that the proposed CNN model might be able to classify fruits. A SoftMax function is then used to divide the visual data into fruit types [8].

The conventional techniques for identifying leaf disease are laborious, subjective, sluggish, and ineffective. A vision-based approach uses convolutional neural networks, bags of features, gray level co-occurrence matrices, and histograms to extract features. The classification is performed using approaches based on support vector machines.

Leaf classification is challenging because of its many varieties and shared characteristics. The Pure Convolutional Neural Network (PCNN) achieves 98.88% accuracy in leaf identification. Seven convolutional layers make up PCNN, several of which are stride-followed [11].

The natural product industry is starting to realize how valuable machine vision and image analysis technologies are. It has been shown in this field that machine vision frameworks can be applied to improve item effectiveness while freeing people from the traditional fundamental sorting of natural items. Several image processing techniques for classifying leaves are covered in this work. The author employed this method to find leaves [12]. This section highlights the use of the dense CNN algorithm to successfully recognize and indicate the evident faults in mango leaves. To identify and categorize the mango leaf photo collection, photographs are collected and split into two groups: excellent and wounded. [15]. A contemporary Techniques for fully automated leaf assessment based on a model are proposed. The computerized structure records video footage from a conveyor system that has a CCD sensor mounted on top of it. gathers a few key details from the picture analysis that are connected to the maturity and freshness of the leaf. The algorithm uses fuzzy heuristics to divide the leaves into two categories. The author employed a machine vision-based leaf recognition device [16]. Leaf skin problems can be identified by applying image processing technology, which has been demonstrated to be considerably more accurate, robust to visual pollution, and having another more reasonable calculation technique. Within this local image patch, the color histogram is extracted as an image inclusion, and the classifier is trained using a linear Support Vector Machine (SVM) [19]. In my work area, the proposed CNN model gives extremely high accuracy in reaching the conclusion that mango leafs are good or diseased.

2.3 Comparative Analysis and Summary

I analyze a large number of research and other sources on my issue and finally decide to employ convolutional neural networks (CNN). Nevertheless, I recently used a number of models to confirm that those are resnet50, VGG16, densenet, efficientnet, InceptionV3, and mobilenet. CNN's picture categorization efficiency is constantly among the top. Finally, I used resnet50 to get the best accuracy.

• This algorithm works well with natural mango leaves. It now blends with our goals, manner of working, and degree of drive. With an accuracy rate of 99 percent or more, resnet50 provides the best performance for other image classification and identification algorithms when properly trained.

• I can easily include it into our new work plan if I have the appropriate advancement information. There are also a number of easily gathered internet resources.

•It works essentially on all products, but it performs noticeably better than other models when it comes to figuring out how diseased mango leaves are. Moreover, it is simple to determine if a leaf of that kind is excellent or bad.

• I can produce outcomes that are satisfactory and highly accurate thanks to resnet50 layers.

I have selected CNN (Convolutional Neural Network) as the primary classifier, and I am utilizing CNN layers and deep learning approaches. I use Scikit-Learn, TensorFlow, keras, pandas, NumPy, and matplotlib on the backend to construct the system. My main goal is to use a Jupiter notebook and an internal database. Utilizing a 6GB NVIDIA GTX 1660 to facilitate quick processing of CUDA Code. The Nvidia GTX 1660's appeal stems from its capacity to enhance performance while staying in the affordable graphics card category. My final target is to construct machinery that could really distinguish among good and diseased mango leaf, as well as continually evaluate the outcomes.

Consequently, in order to construct my CNN layer, I employed the Normalization layer, MaxPooling2D layer, Dropout layer (using 5 layers), Con2D layer (using 12 layers), flatten layer, and activation layer. Items that are difficult to find cannot be categorized since doing so would decrease prediction performance. I gather a great deal of data because of this. There are two distinct varieties of produce in my database of mango leaves. I should be able to reach a reasonable level of accuracy. I act as though we can recognize distinguish between good and bad, as well as assess the quality and health of a leaf.

I have created a web application to make our work easier and more user friendly. Implementations steps are given below:

Choose the desired picture:

1. To get a result, we can use the camera to take a real-time picture. The application that shows us how to select an image of a mango leaf and present our findings is provided below.

2. Forward the picture to the other API server:

The program can determine the percentage of a mango leaf that is healthy if we choose one that has a sickness. Next, choose a desired image from the gallery or take a leaf directly.

3. Retrieve the outcome:

To get a result, we can use the camera to take a real-time picture. The program that shows us how to select an image of a leaf and present our findings.

4. Display the outcome:

Ultimately, our application display will present the anticipated outcome.

2.4 Scope of a Problem

Mangos are a popular fruit among the people in our nations. However, people in our nation often face a range of problems due to their incapacity to accurately differentiate between healthy and unhealthy fruit leaves. My goal is to develop a system that would make it easy to differentiate between healthy and dangerous mango leaves. I chose this classification strategy because, as we have shown via a number of my studies, convolutional neural networks do this kind of job incredibly effectively. In the future, these technologies will be usable in a range of settings, including enormous factory superstores. My algorithm is now trained to identify Bangladeshi mango leaves.

My project will be developed as open source web application that everyone can use for free. My approach makes it easier for workers to perform their jobs in different farming locations across the country where sick leaves are cultivated.

2.5 Challenges

2.5.1 Data Collection

First of all, I've never worked with deep learning before. It is something completely different for us. I had to get all of the information from outside sources. I have gathered the data under a variety of unfavorable conditions, including the sun and rain. This circumstance affects my primary goal, which is to gather unprocessed data. Because of this, I am unable to fully contribute to this research. I physically gathered my data from farmers. I must thus carry out my testing and training procedures in order to demonstrate the existence of this disease identification. I hold off till our final solution in order to get superior results.

2.5.2 Model Selection

Model identification is the most crucial and successful aspect of the approach. Validation and training sets are used to mimic new data. Deep learning methods appear to be widely accessible. Choosing the right model from the group of them is somewhat difficult. Choosing the right model and the right data makes the process easier to finish in general. There are several types of image classification models available. After that, we assessed our system's performance using the CNN model. CNNs are used for photo classification and identification due to their high accuracy. Scikit-Learn, TensorFlow, keras, pandas, NumPy, and the matplotlib library are used in the implementation of our model.

2.5.3 Comparison

Initially, I developed our system using our CNN model. To find out if it genuinely offers the best accuracy or if a different strategy yields better results, it is compared to two different algorithms. Hence, resnet50, VGG16, densenet, efficientnet, InceptionV3, and mobilenet are the six model types that are used here. Here, I mostly ran across a lot of problems. It is quite difficult to train this densenet and InceptionV3 model. The process of creating this model takes a long time.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

Bangladesh's economy is based primarily on agriculture. Our study primarily focuses on mango leaves, a fruit found in Bangladesh. mostly because our income comes from farming. Bangladesh's agricultural sector employs 42.7% of the labor force and contributes 14.2% of the nation's GDP. The number of fresh fruits is growing daily. Health-conscious consumers consistently choose premium, organic fruits. Fruits include nutrients, enzymes, and plant-based products. They are also quite high in fiber. Mango leaf disease detection and classification require a methodical, well-thought-out approach that combines agricultural science and image processing tools [8]. The strategy used to accomplish the research objectives is described in this section, with a focus on the necessity of a strong and trustworthy technique in order to create an automated system for disease detection in mango orchards.

3.2 Research Subject

In the twenty-first century, the industries that produce mangos are becoming increasingly involved. The interaction between fruit manufacturers and importers is determined by both the outflow of fruit demand and international trade. For this quantity of leaves, there is a detailed and time-consuming identification procedure. Therefore, it is anticipated that fruit output will decrease even further in comparison to previous years' worldwide agricultural production and export. Unstable environmental trends, climate change, and rising temperatures are some of the main causes of the collapse of trade, it is not just another problem.

3.3 System Architecture

An architectural description is a comprehensive specification and depiction of a system. System architecture includes structure, additional qualities, and a phenomena characteristic. Many interconnected sub-systems, which can be a part of a suggested system, will carry out the execution of an ultimate system. Our recommended system diagram is shown in Fig. 3.1. Here, we detail every step of our workflow. All of the components of the system are visible within the structure. The architectural style illustrates the general and abstract perspective of the system's operation, as was mentioned in the overview section below.

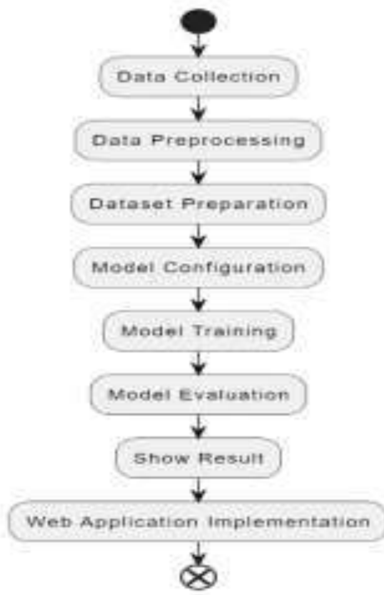


Fig.3.1 Methodology Diagram

3.4 Data Collection

I used some commonly available Bangladeshi fruit mango leaf in our research. I have collected my required dataset from mango tree. The gathering of a varied and representative dataset of photos of mango leaves is a key component of the process. From several mango orchards in Bangladesh, a wide range of healthy and sick leaf samples were collected in order to verify the efficacy of the disease diagnosis technique. To capture the variation in disease symptoms, leaf textures, and environmental circumstances, a variety of samples have been included. For identification, the dataset includes good leaf and diseased leaf.

Below, you can find sample images of some of the good mango leaf in Figure 3.2.

Fig. 3.2 Good mango leaf from dataset

Below, you can find sample images of some of the diseased mango leaf in Figure 3.3.

Fig.3.3 Diseased mango leaf from dataset

The training and testing datasets were derived from it. I used 80% of the photos in the training section, 10% in the testing section, and 10% in the validation section. Here, I mostly divided my dataset using the industry standard. I have displayed this data allocation in Table 3.4 for convenience.

Table 3.1 Data collection

Class Name	Number of Training Data		Number of Testing Data	
	Good	Diseased	Good	Diseased
Good	2000	2000	250	250
Diseased	2000	2000	250	250

3.5 Data Preprocessing

The process of transforming information from one form which is often less desirable and helpful into another which is significantly more desirable and instructive is known as data processing. Numerical approaches, analytical skills, and machine learning techniques can all be used to handle this process. The word "data preprocessing" is crucial. In my research, I've broken down data preparation into distinct sections. It assists me in producing the desired results. Determining the percentage of healthy and damaged mango leaves is our first goal while examining the photos.

3.5.1 Data Visualization

Visualizing is the term often used to describe the visual representation of information and documentation. Data representation strategies use visual elements such as graphical charts, graphs showing, and locations to provide an easy way to view and understand statistics, exceptions, and structures within information. This plot graph primarily shows the data visualization of our photos' heights and widths. Since raw data must be viewed before analysis, this is where I mostly display my data. I now have a better understanding of the data's characteristics and their similarities.

View and check Dataset

First, review everything and make sure the dataset is correct. View data refers to the information I gather that each of us sees individually. Following the effective completion of the collection of data gathering procedures, the data were reviewed and made more effective by eliminating information that was not relevant.

Remove unnecessary image

In my dataset, there is just one category of data. I have to see to it that the data is first divided into classes. Furthermore, two object classes are not compatible. Should any such superfluous data exist, it ought to be eliminated. My method of gathering the dataset was random. On the other hand, the interconnected processes need new data. This makes the step extremely important.

Remove background

Deleted the entire picture's backdrop. In order to exclude the background from the dataset, the "rembg" third-party software was utilized. My duty is lot easier now that I have this library. This inquiry would be very difficult and time consuming to finish in Photoshop. Because of how big my data set is This package provided a quick and simple solution to my issue. I've included some of my data pictures in Fig. 3.4. All of the datasets that I gathered after finishing this backdrop removal section are displayed in this manner.

Fig.3.4 Background remove from Dataset

Image Enhancement

Then the next term is image inhancement on all dataset. Here I used Contrast Limited Adaptive Histogram Equalization (CLAHE). Contrast Limited Adaptive Histogram Equalization (CLAHE) is an image enhancement technique that improves the local contrast and visibility of details in an image. Unlike traditional histogram equalization, CLAHE operates on small, overlapping regions within the image, limiting contrast enhancement to prevent oversaturation. The algorithm uses a parameter called "clipLimit" to control the extent of contrast enhancement and a "tileGridSize" to define the size of the local regions. CLAHE is particularly useful for images with varying illumination conditions and helps reveal details in both bright and dark areas [13]. In my thesis, I would describe the application of CLAHE, discuss parameter choices, and showcase visual examples of the enhancement, emphasizing its relevance to improving the analysis of mango leaf images. A sample of our dataset's photos is shown in Figure 3.5, which shows how the full dataset looks after the image enhancing algorithms are applied.

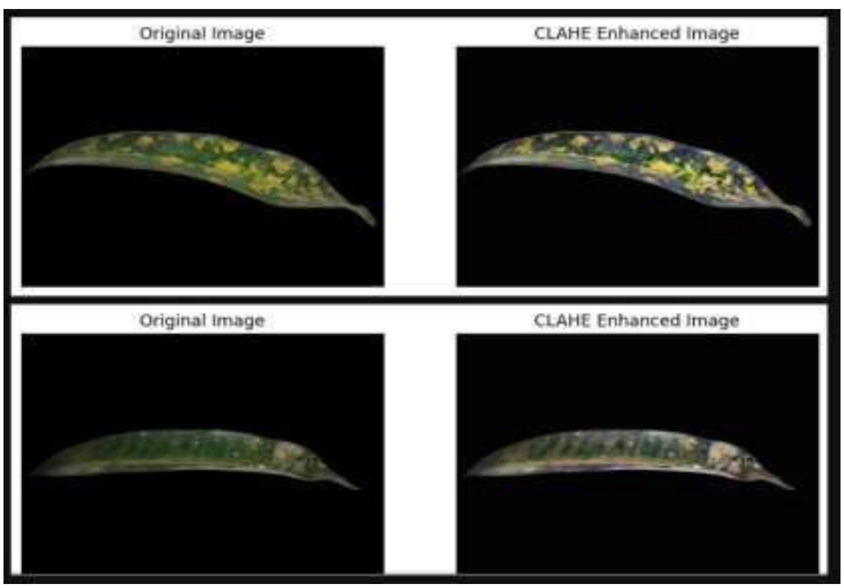


Fig.3.5 Image Inhancement from Dataset

Data Augmentation

By adding different changes to the current photos, I can improve the diversity of my dataset using the approach known as data augmentation. This enhances the durability and performance of machine learning models, especially in situations where the amount of dataset accessible is constrained. Rotating, flipping, zooming, adjusting brightness and contrast, adding noise, and other techniques are common augmentation methods. I help the model discover patterns in fresh, unknown samples and increase its ability to generalize to other contexts by intentionally introducing variances into the data. In the given example, an ImageDataGenerator is used to apply several augmentations to an example image of a mango leaf using Python and the Keras library, resulting in a set of augmented images for training. I have augmented all the data from 2700 to 5400 and unnecessary data has been removed.

Change picture data and store it for the trainset

Next, create an image dataset by classifying the image data. Here Since not every image in the dataset has the same dimensions, each image is resized in this instance based on its category. NumPy arrays are created from images to facilitate analysis. A neural network's input has a size of 224*224 pixels. Since the machine can only handle floating and integer values and cannot understand RGB values, the scaled photo is converted to NumPy [18]. Every pixel becomes a float variable thanks to NumPy. All values are initially in three dimensions and subsequently transformed to one dimension because my input layer is one dimension.

3.6 Proposed Methodology

Classification methods are used to group data into classes or categories. It can be conducted using both structured and unstructured data. CNN algorithm has been used by me in research.

3.6.1 Algorithm Classification

In this study, I developed an image classifier for identifying healthy vs. diseased mango leaves using Python and OpenCV. CNN concentrates on identifying relevant components inside the image rather than evaluating the entire context. There are several levels of CNN that are invisible to the naked eye. both as an input level and as an output level concurrently. I'll use Convolutional Neural Networks (CNN), one of the most popular machine learning methods for classifying photos, to get where I'm going. Convolution is a technique that allows two analytical operations to be combined into one function. As everyone is aware, computers can identify and retain visual cues through a machine learning technique called CNN, which helps them determine whether or not a new photo has been added to the database. Figure 3.6 depicts our CNN model's operational process.

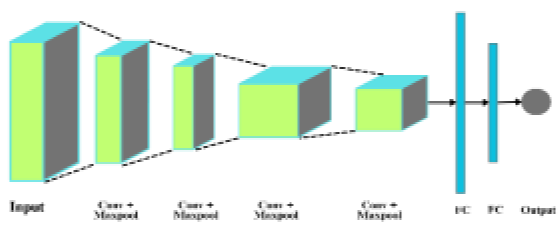


Fig 3.6 CNN classification

3.7 Output

I've displayed a few of my experimental findings here. In my research, I have examined mango leaves from Bangladesh. Here are a few instances of output. With my method, a sick leaf can be located easily. Our anticipated outcome is available here. We obtained 99.46% accuracy when we choose fresh leaf. Other leaves continue in the same way. Good leaf segmentation with information photos. Accuracy for sick leaves is 98.12%. A detailed list of all the output data is provided below.

3.7.1 Showing Result

3.7.1.1 Detection of Good Mango leaf from Dataset Images:

I started by looking at the well-known mango leaf in Bangladesh. Mango production ranks second in Bangladesh, and the country boasts the third-largest agricultural region in terms of land area. As you can see, my system correctly identified the nice mango leaf when I chose it, with an impressive 100% accuracy rate. Fig. 3.7 shows our results.

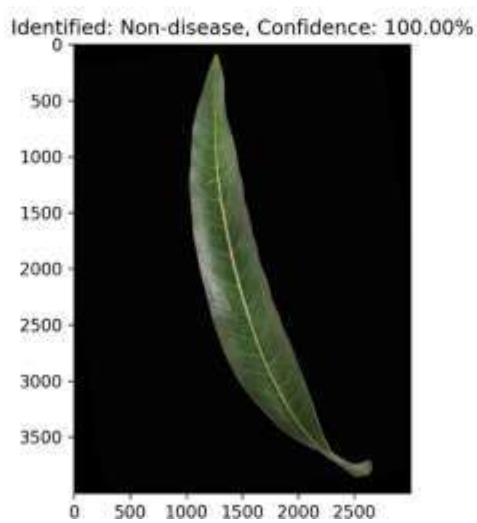


Fig. 3.7 Detection of non-disease mango leaf from dataset images

3.7.1.2 Detection of Diseased Mango Leaf from Dataset Images:

The same is true when I examine sick mango leaves in dataset photos. My approach yields the desired outcome here as well. My system determined the percentage of diseased leaves when I selected one, and the result was 100% diseased accuracy. My output is displayed in Fig. 3.8.

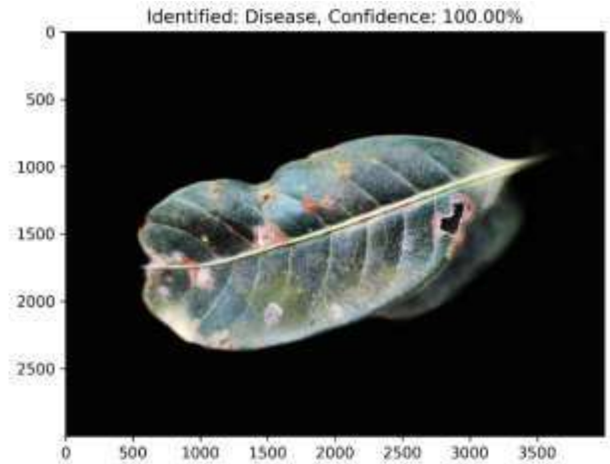


Fig. 3.8 Detection of disease mango leaf from dataset images

3.8 System Implementation

I have created a web application to make my work easier and more user friendly.

1. Capturing and Selecting the target photo & send the photo the rest API server:

Next, choose a desired image from the gallery or take a picture directly, then send it to the other API servers to obtain accuracy. We originally developed an API using the Python Flax framework. For this reason, when I take a picture with my Android device and send it to my created server, the server processes it and displays the outcome. As an example When I choose a diseased mango leaf, the app will analyze it and indicate what percentage of it is healthy. The second interface of our application is shown in Fig 3.9. In order to make it simple for users to comprehend what they can do, my system suggested taking pictures directly.

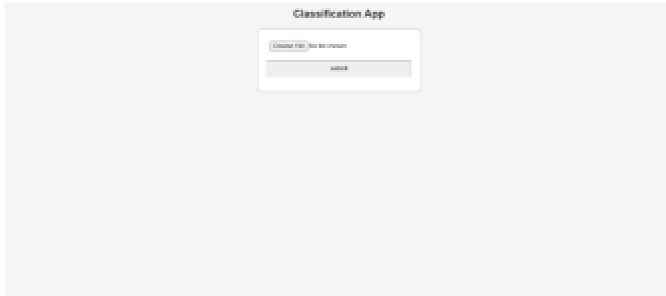


Fig. 3.9 Interface my system

2. fetch the result & show the result:

The program is shown below, and it shows how I will select the leaf image and provide my findings. I selected the picture in the image from the gallery to get the desired result. I can use the camera in this way to take a real-time picture and get the outcome. Here, retrieve and display the leaf Fig. 3.10 result. It's a nice leaf, according to our program, because 98.26 percent of it is fresh.

Fig. 3.10 Fetch the result & show for Good leaf

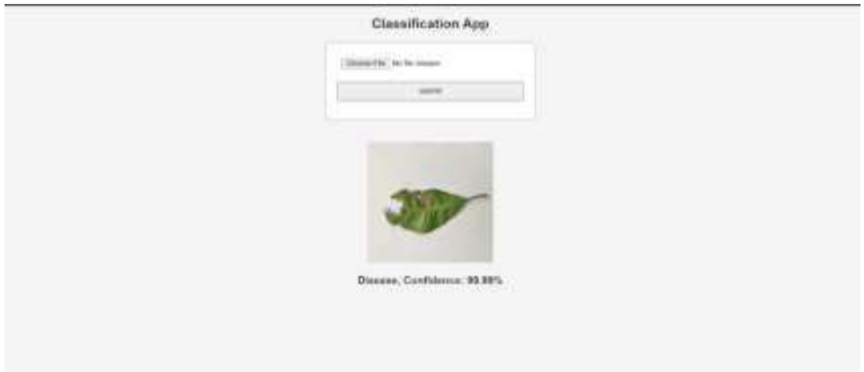


Fig. 3.11 Fetch the result & show for Diseased leaf

An analogous process, where in the application analyzes images of a mango leaf, is depicted in Figure 3.10 and Figure 3.11. After selecting an image from their gallery, users choose the 'Upload & Predict' option. The image is then automatically processed by the system, and the results are shown.

CHAPTER 4

EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Model Accuracy

A metric known as "model accuracy" is used to determine which model, when applied to training data, is more successful in identifying patterns and correlations among data samples. We observe that overall accuracy increases at every stage of the procedure. Then, we achieve both an adequate Val accuracy of 100 percent and a training accuracy of up to 99.95 percent.

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} ------ (1)$$

Equation 1's confusion matrix is commonly used to assess the effectiveness of the categorization process. The following list displays true positives (TP), true negatives (TN), false positives (FP), and false negatives (FN). An evaluation that produced favorable outcomes and fulfilled expectations is a true positive. The true negative (TN) rate is the proportion of predicted values that are truly negative. False negative (FN) observations show that positive values were predicted to have a negative correlation for the different kinds of data sets. Observations that are projected as positive but are actually negative are known as false positives (FPs).

4.2 Model Training

Model training using 80% of the data is a common practice in machine learning. This approach involves splitting the available dataset into two parts: 80% for training the model and 20% for testing and evaluating its performance. The 80% portion allocated for training serves as the input for the model to learn patterns, relationships, and features within the data. This set is crucial for the model to generalize well to unseen data. Train the model using the 80% training data, feeding it batches of samples iteratively. The model learns to map input features to the corresponding output labels during this process. The Training accuracy of 99.95% in my thesis.

4.3 Model Testing

Once training is complete, evaluate the model's performance on the separate 20% testing set. This set simulates real-world, unseen data, providing insights into the model's ability to generalize. The model makes predictions on the features in the testing subset, and these predictions are compared to the actual target labels. The goal is to assess how well the model generalizes to new, unseen data. The Testing accuracy of 99.46% in my thesis.

4.4 Model Validation

Model validation is a crucial step in the development of machine learning models, ensuring that the trained model generalizes well to unseen data. Validating a model on a separate dataset helps assess its performance, reliability, and potential for real-world applications. After training, the model's performance is evaluated on the 10% validation set. This subset of the data was not used during training, providing an unbiased assessment of how well the model generalizes to new, unseen examples. The validation accuracy of 100%, our validation loss of 0%.

4.5 Algorithm Techniques

I used the CNN algorithm and six types of model used here. The six types of model are resnet50, VGG16, densenet, efficientnet, InceptionV3, mobilenet. The Classification algorithm has a validation accuracy of 100%, our validation loss of 0% and a training accuracy of 99.95%.

Resnet50 model has the maximum accuracy in this analysis, thus. 4.1 table has been updated with a brief explanation.

Table 4.1 Algorithm technique

Model	Epoch	Data Source	Training Accuracy	Testing Accuracy	Validation Accuracy
resnet50	27	Self Collected	99.95%	99.46%	100%
VGG16	23		99.37%	97.37%	99.10%
densenet	24		99.14%	98.02%	98.56%
efficientnet	31		99.66%	98.20%	99.10%
InceptionV3	28		99.88%	96.94%	98.38%
mobilenet	33		99.98%	98.92%	99.28%

4.6 Confusion Matrix

A confusion matrix is a powerful tool for evaluating the performance of a classification model. In the context of your thesis on mango leaf disease detection using various deep learning models such as ResNet50, VGG16, DenseNet, EfficientNet, InceptionV3, and MobileNet, the confusion matrix helps quantify the model's ability to correctly classify mango leaves into disease detection.

Now I discuss how the concept of training, validation loss, accuracy and confusion matrix applies to several popular pre-trained deep learning models:

(I) ResNet50:

I would compute and present the training, validation loss, accuracy and confusion matrix during the evaluation phase. Refer to Figure 4.1 for comprehensive training instructions. Additionally, the confusion matrix for the ResNet50 model is displayed in Figure 4.2 and provides a tabular assessment of the model's performance.

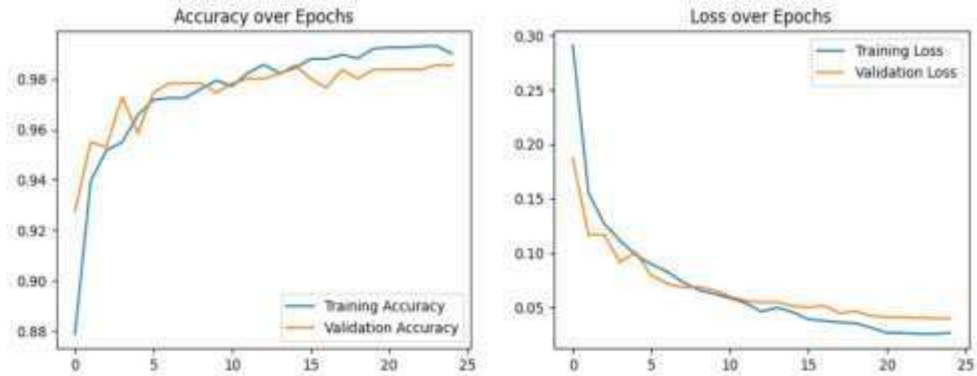


Fig. 4.1 training, validation loss, accuracy in ResNet50

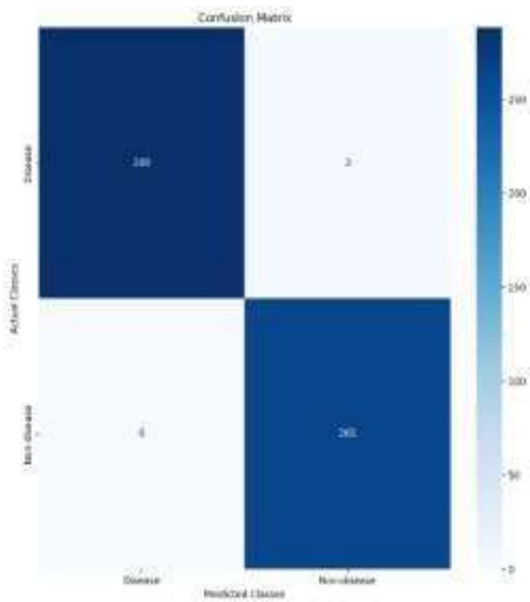


Fig. 4.2 Confusion matrix in ResNet50

(II) VGG16:

I would compute and present the training, validation loss, accuracy and confusion matrix during the evaluation phase. Refer to Figure 4.3 for comprehensive training instructions. Additionally, the confusion matrix for the VGG16 model is displayed in Figure 4.4 and provides a tabular assessment of the model's performance.

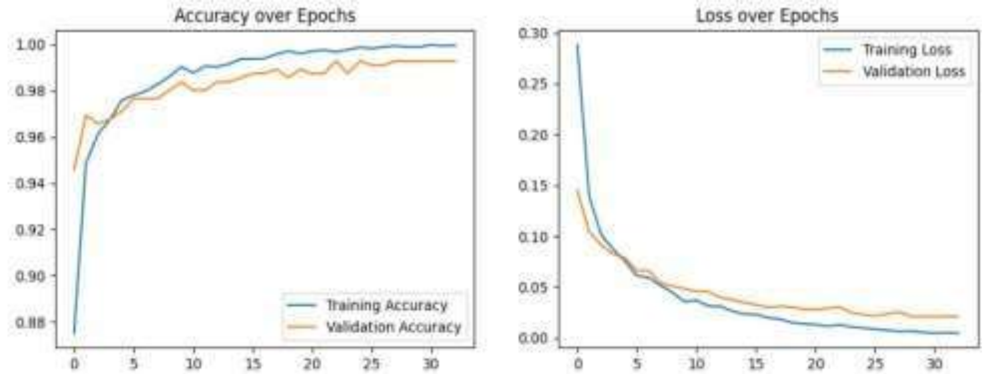


Fig. 4.3 training, validation loss, accuracy in VGG16

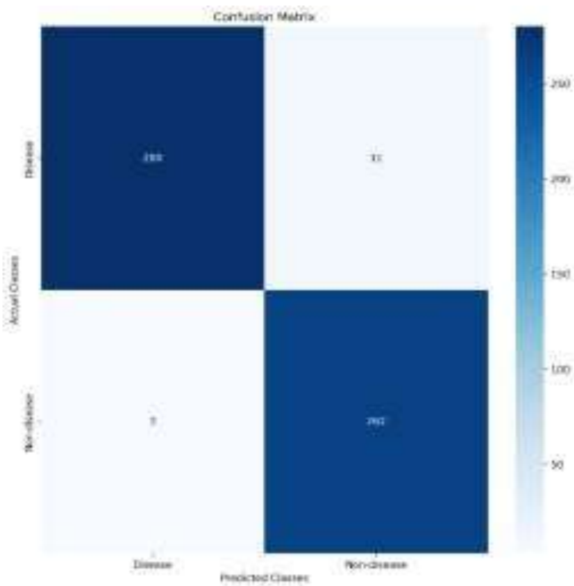


Fig. 4.4 Confusion matrix in VGG16

(III) DenseNet:

I would compute and present the training, validation loss, accuracy and confusion matrix during the evaluation phase. For detailed directions on training, see Figure 4.5 Furthermore, Figure 4.6 shows the confusion matrix for the DenseNet model, which offers a tabular evaluation of the model's performance.

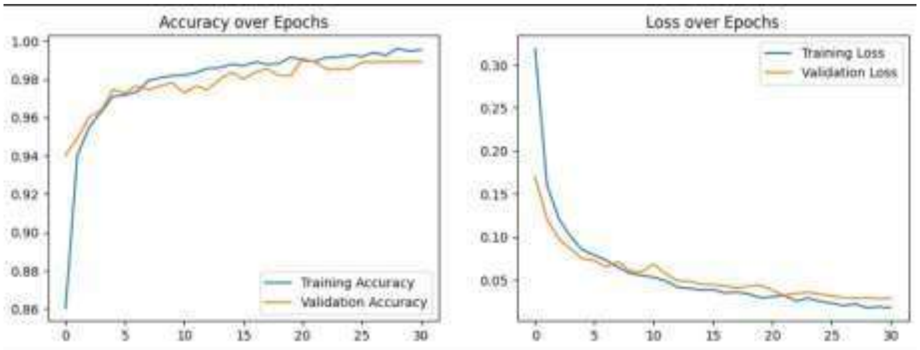


Fig. 4.5 training, validation loss, accuracy in DenseNet

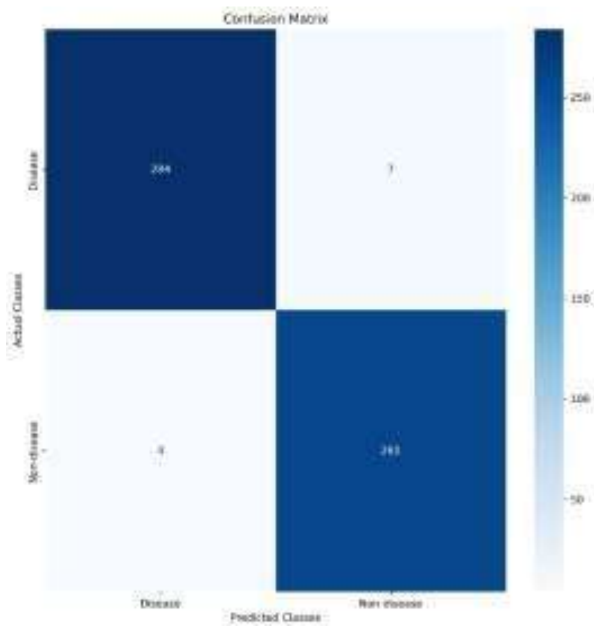
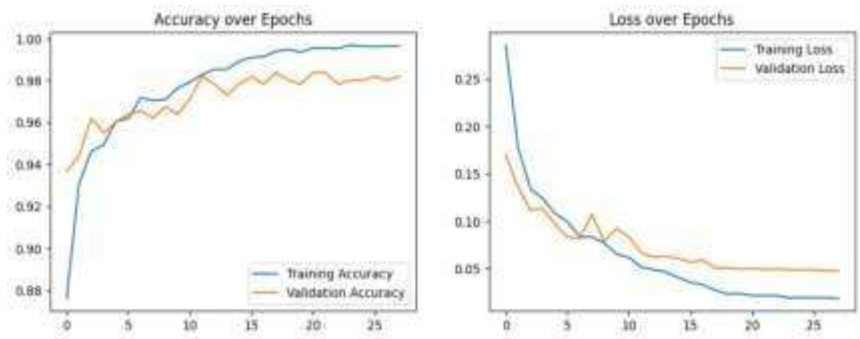


Fig. 4.6 Confusion matrix in DenseNet

(IV) EfficientNet:

I would compute and present the training, validation loss, accuracy and confusion matrix during the evaluation phase. Refer to Figure 4.7 for specific instructions on how to train. In addition, Figure 4.8 presents the confusion matrix for the EfficientNet model, providing a tabular assessment of the model's functionality.



. Fig. 4.7 training, validation loss, accuracy in EfficientNet

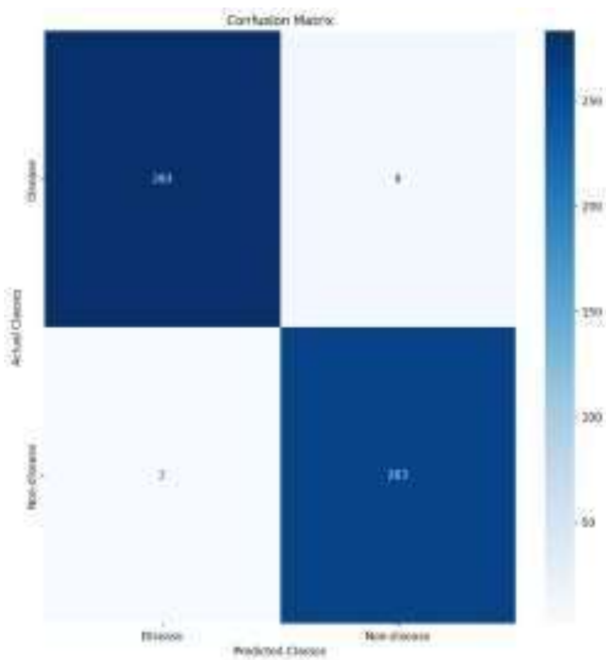


Fig. 4.8 Confusion matrix in EfficientNet

(V) InceptionV3:

I would compute and present the training, validation loss, accuracy and confusion matrix during the evaluation phase. For detailed guidance on training, see Figure 4.9 Furthermore, a tabular evaluation of the InceptionV3 model's functionality is provided by the confusion matrix, which is shown in Figure 4.10.

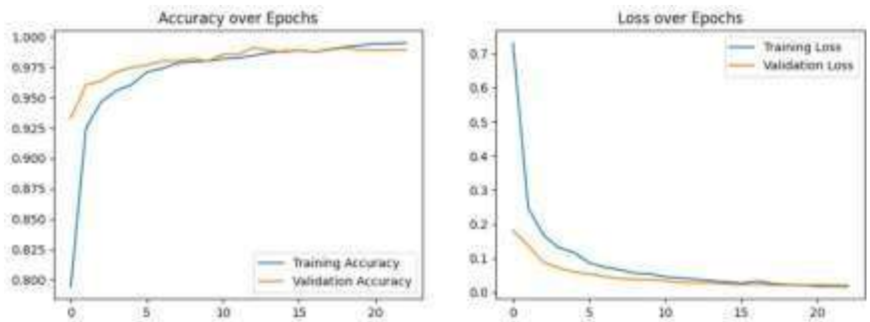


Fig. 4.9 training, validation loss, accuracy in InceptionV3

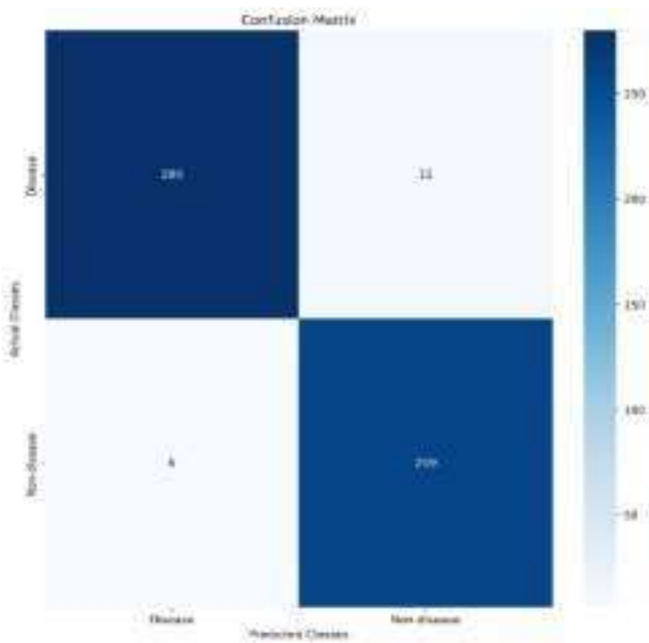


Fig. 4.10 Confusion matrix in InceptionV3

(VI) MobileNet:

I would compute and present the training, validation loss, accuracy and confusion matrix during the evaluation phase. See Figure 4.11 for comprehensive training guidelines. Moreover, Figure 4.12 confusion matrix provides a tabular assessment of the functionality of the VGG16 model.

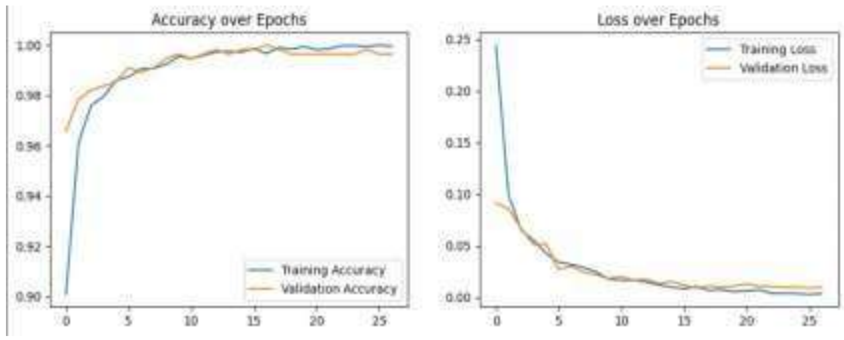


Fig. 4.11 training, validation loss, accuracy in MobileNet

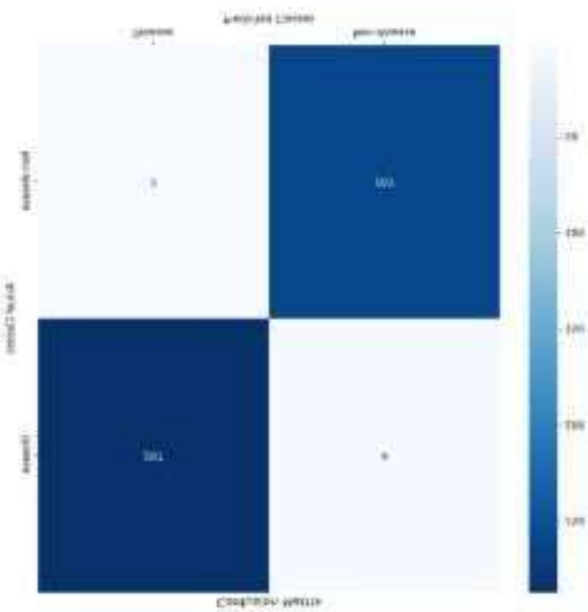


Fig. 4.12 Confusion matrix in MobileNet

4.7 Result Discussion

After analyzing all of the data I had gathered and developing the model using the information provided, I had the intended outcomes. I found that my model is performing really well and can accurately detect infected free and diseased mango leaves 97% of the time after using training and test data. Our expected results came from the resnet50 model, and before I could finally select my optimal system, five other models were also examined for comparison.

CHAPTER 5

IMPACT ON SOCIETY, ENVIRONMENT AND SUSTANABILITY

5.1 Impact on Society

Our nation is primarily an agrarian nation. The majority of the villagers labor in agriculture for a living. In our study, we mostly work with the common fruit, mango leaf, from Bangladesh. Mango leaves were gathered for our dataset. Those leaf kinds are highly prevalent. Our primary goal is to reach as many individuals as possible. Because we have also implemented our findings into a web application, the general public can utilize it to increase production while keeping plants fresh. In our nation, Android feature phones are used by the majority of individuals. Thus, we believe it to be user-friendly. Simply take a picture or choose one from the gallery, and our analysis verifies the state of the leaves. Both general public members and farmers can benefit from our work.

5.2 Impact on Environment

We use deep learning to develop this kind of automated system to ensure that the problem of keeping plants fresh and increasing yield is resolved. The vast majority of people Mango cultivation is widespread in Bangladesh. There isn't enough time for them to determine whether the leaf is fresh. Thus, they can currently make use of our technologies. People usually have no reason to worry about that. The purpose of building this kind of automation system is to lessen yield issues and problems of this kind.

5.3 Ethical Analysis

A methodical procedure called ethical analysis can be used to discover the right moral course of action in a certain situation. By applying your moral values to the problem and doing a logical analysis, you may decide whether or not the answers are both desirable and workable. When making decisions, you should carefully evaluate the circumstances and the effects of your decisions, according to the ethical assessment principles. You can use ethical analysis to reorient your organization when subordinates or workers behave unethically.

I mostly use Bangladesh's perspective in my research. My primary goal is to reach as many individuals as possible. Anyone in any profession is able to use our system. People in the farming industry can use it to learn about the state of their mango leaves. They can thus use it with ease.

CHAPTER 6

SUMMARY, CONCLUSION AND IMPLICATION FOR FUTURE RESEARCH

6.1 Summary of the Study

The purpose of my experiment was to see how well an image could distinguish between healthy and damaged mango leaves. I found that CNN can identify photographs really well in my post. I obtained my original study data from a number of different organizations. After preprocessing, I divide the training and assessment to complete our project. I eventually received the desired outcomes. I'm also developing my system as an online application to make it more user-friendly. Given that the farming industry uses Android phones and that the majority of workers are familiar with them, using such an application shouldn't be too tough. In light of this, we developed an application that uses image captions to provide information on the quality of mango leaves.

6.2 Result Comparison

It will be simpler to comprehend the main distinctions and similarities with the help of this table 6.1. Determining which alternative might be the greatest option and why is helpful. I may more persuasively support the study's conclusions and arguments by arranging the data in this manner.

Table 6.1 comparison with some previous works

Work	Algorithm	Accuracy
Machine Learning based Classification of Diseased Mango Leaves	Decision Tree, SVM	98.6%
Mango Leaf disease Classification using deep learning Hybrid Model	SVM, SVGD	97.2%
Automatic Mango Leaf and Trunk Detection as Supporting Tool of Mango Pest Identifier (MPI)	Faster R-CNN	95.71%

Mango Leaf Diseases Detection using Deep Learning	CNN	90.36%
Mango Plant Disease Detection Using Modified multi Support Vector Machine Algorithm	SVM	97%
Mango Disease Detection by using Image Processing	SVM	90%
Mango Leaf Stress Identification Using Deep Neural Network	CNN	98.12%

The number of researchers who have employed various algorithms and achieved varying degrees of precision and accuracy is displayed in the following table 6.1 the highest accuracy is 98.6%. In this study, SVM is used to identify the illnesses of mango leaves. An other research paper gets an excellent 98.12% accuracy rate when using the CNN approach to determine mango leaf stress defection. Mango leaf disease is frequently identified using this technique. Here, the reliability is only 90.36%, which is below the threshold. The subsequent investigation distinguished the mango leaf disease from the rest with 97.2% accuracy using SVM and SVGD. The reliability of using Faster R-CNN for this mango leaf disease identification job is lower than it was previously. Made up of 95.71% is production. I tried putting our strategy into practice after going over all those papers. I was able to identify mango leaf illnesses on a single platform by looking at the aforementioned publications. I just use CNN, and I adjust the photo to fit my needs during data preparation. This device is a significantly better choice for our farmers and the general public because it can discern between healthy and diseased mango leaves with accuracy. With the resnet50 model, I achieve 99.46% accuracy from the CNN algorithm, which is my best accuracy.

6.3 Advantages of The Application

Right now, I receive Various regions of the nation are home to mango farms. Fermenters find it extremely challenging and time-consuming to distinguish between healthy and unhealthy leaves among all varieties. In this instance, the public will benefit from my system. With the help of our technology, they can quickly determine whether or not this leaf is fresh. My main objective is to become well-known to everyone. I also create a web application as a result. as the majority of people in our nation are able to operate an Android feature phone. I create a basic program. Here, the user simply takes a picture of a mango leaf, and my algorithm determines if the leaf is healthy or sick. What percentage of the leaf, if it is good, is provided by my system? For clarity, it will also be displayed as a pie chart. In a similar vein, the proportion of diseased leaf will be displayed if it is not new. Farmers and other individuals will find my system to be very useful. In this instance, my application can assist them. They'll be able to judge the quality of the leaf in a short while. My system will be beneficial to our farming community as well. Since they can equally readily discover it. because our nation's farmers are consistently disregarded.

6.4 Conclusion

This study suggests a novel convolutional neural network technique for the identification of mango leaf diseases. For training and testing, a total of 80% and 10% photographs were used, yielding the results displayed above. The Anaconda program was used to code and test the previous method. For training and testing, a variety of mango leaf varieties from different sources were used. The accuracy rate of the recommended approach was 99.46%. In this work, illnesses of mango leaves are identified using the CNN technique. The efficiency and loss graphs were produced by arranging the convolution layer of the dataset in various ways. This research looks at a variety of approaches and techniques for identifying sick leaves, all of which rely on machine learning.

6.5 Future Work

It is envisaged that the work would be expanded to a bigger data set with additional leaf kinds in the future. Try putting multiple CNN-based algorithms into practice and comparing how effective they are with the same set of data. It is also possible to detect disease types and/or the consequent texture structure by studying it on other criteria for classification and categorization. All of this is a path for the future. I'm going to update my web application with additional features. In the future, I shall make an effort to determine how long a leaf will live and whether it is infected in any way. I shall make an effort to find this because of this.

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PLAGIARISM

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