DEEP LEARNING BASED SPONGE GOURD DISEASE RECOGNITION

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APPROVAL

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We hereby declare that, this project has been done by us under the supervision of **Md. Tarek Habib, Assistant Professor, Department of CSE,** Daffodil International University. We also declare that neither this project nor any part of this research project *has been submitted elsewhere* for award of any degree or diploma.

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ABSTRACT

Sponge gourd or luffa gourd, called as **"ধুন্দুল"** in Bangladesh, is scientifically known as *Luffa cylindrical* that belongs to *Cucurbitaceae* family. It is one of the most easily found vegetables in Bangladesh. It is edible wild vegetables that the plant can be seen anywhere around us during late summer till late autumn in Bangladesh. Cooked sponge gourd or the curry is a bit sweetish in taste. Even though sponge gourd is kind of a wild vegetable plant, in recent time a lot of people are cultivating it in the countryside thinking of profit and commercial production since there is a market demand for it. Despite of having every opportunity to commercial benefit most of the farmers neglect the issue of insects and diseases attack on the plant resulting on huge loss in the business. Also lack of proper knowledge of related diseases, advance technology and trustable source the farmers lag behind the diseases detection process to use pesticides or different methods of reducing diseases attack. If necessary steps can be taken to prevent the insects and diseases attack at the very beginning of cultivation, then the profits will increase as the crop yields increase. This research paper attempts to detect the leaf and flower diseases of spongegourd using Convolutional Neural Network (CNN) and image processing techniques. CNN and image processing are one of the most recently introduced technologies using in the agriculture sector in Bangladesh ensuring highest accuracy. This system will take leaf and flower images as input and after examining them healthy or detected diseases will be shown as output which has reached to the accuracy of 66.63%.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

The people of Bangladesh are always health conscious. Different types of vegetables get priority in the meal list. With the increase in demand, the supply of vegetables is increasing in the market. Seasonal vegetables are sharing place with yearlong vegetables. According to the report of The Daily Star newspaper, the annual demand for the vegetables in Bangladesh is 13.25 million metric tons [1]. But the supply of vegetables in the market is only 3.73 million metric tons per year covering only one third of the total demand. The price varies from place to place and especially the rate of sponge gourd per kilo varies from 30 to 60 BDT depending on weather. Sponge gourd is a creeping plant crop having low yield. The young and green fruits are used as vegetables and ripe fruits can be used for cleaning kitchen utensils and also as a scourer while bathing. For the cultivation of sponge gourd, soil enriched in biomass and sunny weather is preferred.

1.2 Motivation

Every week millions of tons of vegetables get wasted because of diseases attack and lack of knowledge of reducing them. There are people out there in some corner of the world who are starving themselves only because they do not have any kind of food to eat. Some winter countries cannot grow crops and vegetables because of the ice-cold weather. Poisonous pesticides in the yields to get rid of the insects and diseases are harming every element of this world. Since sponge gourd is one of the most common choices of consumers in Bangladesh as local vegetables, we have decided to experiment on this. On account of this, tons of sponge gourd or luffa gourd are marketed daily. To overcome the production constrains, if we can control the diseases and insects attack before the yield comes then the production rate will boost up in general.

1.3 Rationale of the Study

For consummating the necessitate of vegetable of the country ranchers are using harmful pesticides contravening the SDGs (Sustainable Development Goal) to get rid of the insects and diseases attacks. These methods not only harm the soil or field but also draw negative impact on water, air and environment also. Excessive use of harmful pesticides sometimes poisons the yield and consumers suffer from debilitating disorders.

But newly invented technologies can resolve every issues and difficulty of disease detection without the using of poisonous pesticides. CNN (convolutional neural network) [2] and image processing are one of the most effective detection systems in recent years ensuring highest trustable accuracy. CNN [2] has been promoted more and more to rural people by observing its performance. CNN [2] is a model inspired by brain structure. Layers are interconnected to each other depending on previous layers outcome. This neural network consists of a network of neurons technique units. Since this CNN [2] avoids the complexity of image processing system, users of the model get the real time image in no time. Particular degree translation, image rotation, image augmentation, width shift, height shift, sheer in range and sometimes distortion conversation is used by CNN [2] algorithm.

CNN [2] cooperate with the pretrained models. There are more than 15 various CNN [2] models to pre-train the dataset according to the research requirements and subjects. In this research work we have used LeNet, AlexNet [14] to pre-train our raw dataset for detecting the diseases of sponge gourd leaf and flower diseases. About 6 class including 2 healthy class of leaf and flower and 4 disease class has been taken in notice for experimenting our proposed model on collected raw dataset. They are: Downy mildew, Alternaria blight, Anthracnose, Healthy leaf, Unhealthy flower and Healthy flower.

1.4 Research Questions

1. Why does deep learning seize out “interest” for carrying out the research?
2. Do we find a unique subject to employ deep learning algorithms?
3. Does the collection of raw data needed to train the deep learning models?
4. Does deep learning need any particular amount of data, what are our thoughts?
5. Is it beneficial and interesting to learn and apply CNN (Convolutional Neural Network)?
6. Does deep learning allow different areas for deep learning researches? What are they?
7. Do we think Machine Learning and Deep Learning varies from each other?

1.5 Expected Outcome

The objective of our experiment is to assist the rural ranchers providing the most organic way to cultivate involving technologies. We are hoping our research will expand more interest amongst people and help them to acquire more knowledge on CNN [2] and deep learning since they suggest more options for research subjects. CNN [2] is considered the as black hole of artificial intelligence since it is almost impossible know what is happening inside the networks and how every layer is intimating with each other. Thus, it makes the learning process super fun, captivating and interesting.

Disease detection was always counted as a pain on the back to the local ranchers with little knowledge about the diseases. And a wild vegetable like sponge gourd is always neglected in this arena of commercial cultivation and its disease detection. No technological research has been applied on sponge gourd till today in our country Bangladesh. So, we are hopping our work will help the farmers in need and spread the interest of commercial cultivation of sponge gourd amongst the ranchers solving the most complex issues of disease detection in future.

1.6 Report Layout

This research paper contains following contents as the section below as: In section II, background studies and related work have been discussed. In section III, flow chart of the experiment, data collection procedure, features implementation has been explained. In section IV, experimental evaluation of the research and model architecture have discussed. Section V briefly describes the numerical and graphical outcome of this research and finally, section VI centers the future work and conclusion of the research work.

CHAPTER 2
BACKGROUND STUDY

2.1 Introduction

Sponge gourd is a manifold rich vegetable. It provides natural insulin which is very useful for diabetic healing and also helps to reduce and control excessive cholesterol and body fat. To recover from jaundice, sponge gourd curry is very effective. It is loaded with calcium, phosphorous, iron, fibers and vitamin-B. Since, sponge gourd is a member of *Cucurbitaceae* family, it is enriched in anti-oxidant and has antimicrobial, anticancer, cardioprotective and hypolipidemic qualities [3].

Two species of sponge gourd are found in Bangladesh, one is cultivated to eat as vegetables and other one is found and known as wild sponge ground having non edible bitter taste which is only used as ripe fruit to produce bathing accessories. There are many types of diseases of sponge gourd. To reduce them dry and dead leaves and attacked leaves should be collected and floated in the ground. Otherwise there is a heavy chance of diseases spreading amongst healthy plants. This research tends to detect those leaf and flower diseases using latest technology to combine agriculture sector with computer science and technology.

2.2 Literature Review

This literature review section of this research paper is going to present the near past related works done by some researchers on vegetable diseases prediction. We have followed and studied their work to understand the processes and methods expressed by them.

Mummer TURKOGLU, Davut HANBAY have worked on plant disease and pest detection using deep learning-based features. Their study in this research evaluated the performance results of nine powerful architecture of deep neural network for plant disease prediction. They have obtained features using deep feature extraction and classified the work by support vector machine (SVM), Extreme Learning Machine (ELM), and K-nearest neighbor (KNN) methods. CNN model-based transfer learning is used to pretrain their system in their research work. The ResNet50 model and SVM classifier produced the highest accuracy among these with an accuracy of 97.86% and obtained the best accuracy for the AlexNet model of 95% using SVM classifier. The highest accuracy for the VGG16 model was 95% by using the SVM classifier. The highest accuracy for vgg19 model was 94.74% using ELM classifier [4].

M. Akila, P. Deepan presented their work on deep-learning-based approach to detect leaf diseases in many different plants using image of those plant leaves. The goal was to find and develop the more suitable deep-learning methods that can easily detect the diseases only from plant images. Three main friendly detectors: Region-based Fully Convolutional Network (R-FCN), Faster Region-based Convolutional Neural Network (Faster R-CNN), and Single shot Multibox Detector (SSD) have been used in their research [5].

Sharada Prasanna Mohanty, Davia Hughes, and Marcel Salathe proposed a deep Convolution Neural Network to identify 14 crop species and 26 of their diseases. Their trained model achieved an accuracy of 99.35% during the feasibility test [6].

Santosh Adhikari et al aimed to classify and detect the plant disease automatically for the tomato plant. Image processing, adjusting image RIO, Convolution Neural Network (CNN) have been applied on their research work and an overall accuracy of 89% has been achieved on their plant village dataset [7].

Nadeem Ahmed et al predicted the potato late blight disease based upon environmental factor in Faisalabad, Pakistan. A disease predictive model was developed using two years

data of PLB disease severity and epidemiological factor. Their proposed model explained up to 80% disease variability [8].

M. Donatelli et al proposed a five-stage road map to improve the simulation of the impacts caused by plant disease and pest. Improve the quality and availability of data for model inputs, improve the quality and availability of data for model evaluation, improve the integration with crop model, improve the processes for model evaluation and develop a community of plant pest and disease modelers were proposed and staged by them [9].

Sujatha R, Y Sravan Kumar and Garine Uma Akhil basically work for identification of different kinds of leaf diseases using image processing in MATLAB. The K-means clustering algorithm and Support vector machine (SVM) is proposed here for segmentation. With identification diseases, it will allow user to know about the affected area of leaf in percentage [10].

Prakash M. Mainkar, Shreekant Ghorpade, Mayur Adawadkar predicted plant leaf disease detection using image processing. Three kinds of diseases have been selected for prediction which are bacterial, viral and fungal. K-means clustering, GMCL and BPNN technique used here as a proposed methodology and get 94-96% accuracy compared to the other model [11].

2.2.1 Comparative Studies

There is some work done on different plants and vegetables using deep learning algorithms and image processing system. The comparison between these existing works have shown in this section. Here, the comparison of different research subject and outcome between the related works are given below in Table 2.1.

TABLE 2.2.1: COMPARATIVE STUDIES

Author name	**Research Work**	**Outcome**
Mummer TURKOGLU et al	Plant disease and pest detection using deep learning-based features	97.86%
M. Akila et al	Deep-learning-based approach to detect leaf diseases in many different plants using image of those plant leaves	
Davia Hughes et al	Deep Convolution Neural Network to identify 14 crop species and 26 of their diseases	99.35%
Santosh Adhikari et al	Classify and detect the plant disease automatically for the tomato plant	89%
Nadeem Ahmed et al	Predicted the potato late blight disease based upon environmental factor in Faisalabad, Pakistan	80%
M. Donatelli et al	Five-stage roadmap to improve the simulation of the impacts caused by plant disease and pest	

2.3 Research Summary

With the invention of new technology, the processes to detect the plant diseases are changing for better agricultural and economic growth. In recent years, deep learning which is especially widely use in image processing offers many new applications related to precision agriculture. CNN [2] have succeed to receive the trust and acceptance of agricultural specialist through the whole world. In this research of ours, we have tried to employ CNN [2] to detect the leaves and flower diseases of sponge gourd in Bangladesh with an accuracy of 44.43% on collected raw dataset. In Bangladesh CNN [2] has never

been applied no sponge gourd before which opens a significant opportunity and sector for us to employ a unique research work.

2.4 Scope of the problem

This research work of ours is mainly based on image processing techniques and Convolutional Neural Network [2]. Our proposed model is executed on sponge gourd to detect the leaf and flower diseases. Mostly for the rural commercial ranchers it is tough to detect the diseases of wild and ignorant vegetables like sponge gourd by using local methods or only by guessing. So, we have faced problems while classify the diseases comparing with the information from internet. Since some of the diseases share similar pattern, it is confusing to classify them accurately. To receive help from professionals is costly and time consuming. Often ranchers get tired of seeking the appointment of professional agriculture official appointed by the government and ended up losing interest in commercial cultivation. Our research work is an automatic process of disease detection only from image dataset. All the necessary procedures are done by computers and artificial intelligence help where the CNN [2] model work finely ensuring a high accuracy to detect the leaves and flower diseases of sponge gourd.

2.5 Challenges

While doing this research we have faced some troubles. Some of the challenges are stated below for the future researchers so that they can take precautions:

1. Even though sponge gourd is commonly found vegetables, commercial yield was hard to find for collecting the raw image dataset.
2. City life rarely has sponge gourd yield so visiting the villages and rural areas was challenging for us.
3. Since we have visited the commercial yields, plucking the healthy leaves and flowers were against the ethical values.
4. Some insects were so frightening that we once thought of giving up data collection.

5. Classify the collected images according to different disease pattern was so much difficult since some of them shares really close pattern.
6. Deciding a particular CNN [2] model was hard but at the end our proposed worked really well and did not conflicted.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

The purpose of this research is to commence a new concept of identifying the leaf diseases of sponge gourd in order to help the local farmers of Bangladesh to cultivate and vend them commercially aiming to produce more thrive. For any kind of cultivation, healthy plant or farm is a must. Soil, weather, insects and diseases, cultivation methods are the main barriers for any flatten form of cultivation. Thus, much consideration of ranchers and time to time expert's instruction is needed to be paid. But the cultivation processes and methods for sponge gourd is mostly neglected in our country by labeling it wild vegetables. Maximum cultivate it for hobby or just to fulfill their personal need. To cultivate it professionally, it is a matter of cost, carefulness and time. In any case of insects or diseases attack ranchers need to seek the expert's recommendation which is a bit costly for the native ranchers to appoint an experienced agriculture officer. Also, the exposure procedure is a lengthy process. Artificial Intelligence saves us from this. Specially, image processing system and CNN [2] solve all these hurdles with less effort, low cost and expedition in a more professional way.

3.2 Research Subject and Instrumentation

Making our propose easier we have elected sponge gourd as the core vegetables on which we will apply our proposed method. Our proposed method woks taking the insect or disease attacked leaf image as an input. After inspecting and comparing the input image with the pre-trained machine an explanatory output is offered by the system which detects the disease name. Only by clicking the insects attacked or diseased leaf's picture and input them into the system we have created, an informational output with the name of the disease will be shown to the farmers. So, CNN [2] can be the easiest procedure for the

native ranchers to perceive the disease name and provide the necessary pesticides in time from escalating the diseases to the fruit.

3.2.1 Proposed Methodology

Our proposed methodology is shown below in Figure 3.1.

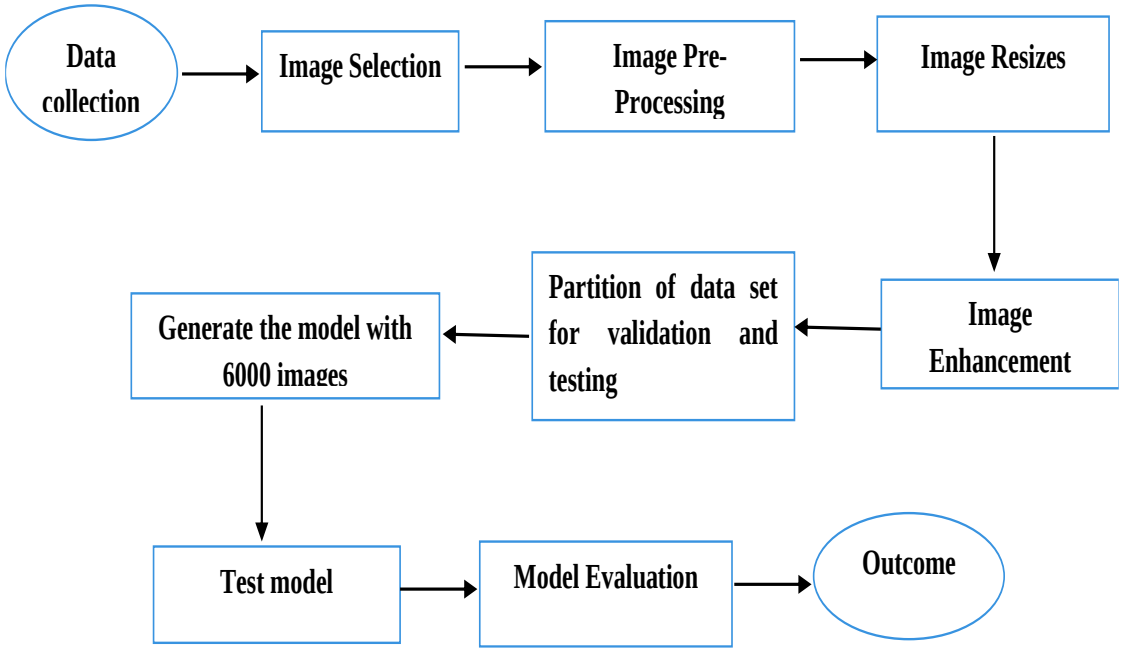


Figure 3.1: Our proposed methodology

In this research paper we have used supervised learning method [12] of CNN [2] algorithm and sequential model of Keras [13]. AlexNet [14] is used for drawing the model architecture. TensorFlow [15] has been used in the backend including Keras [13]. Adam optimizer [16], Matplotlib.pylib [17] have used for various purposes. Different CNN [2] layers converted this research into a practical form giving the theoretical thoughts into reality.

3.2.2 Supervised Learning

Supervised learning [12] is a method to train the machine with labeled dataset where some veracious data are already given. By learning from the given labeled dataset, the machine gives an output for unknown or unforeseen data to predict or detect the subjects or objects. Performances of supervised learning [12] can be optimized by using experience criteria where it allows one to create or produce the required dataset to train the machine with proposed model. Basically, for solving the real-life computation issues supervised learning [12] is a great choice.

3.2.3 TensorFlow

TensorFlow [15] is counted as an end-to-end platform for machine learning algorithms. It is an open source software library that is adjusted to serve the numerical computation. Mathematical expressions which use the data flow graphs while completing the numerical computation use TensorFlow [15] as backend. For originating faster, easier and interesting machine learning methods, TensorFlow [15] is the best choice. A common metaphor uses the combination of deep learning and machine learning bundles done by TensorFlow [15]. It provides a flexible, comprehensive, adaptable ecosystem of libraries, tools and community resources for the researchers for deploying machine learning powered algorithms.

3.2.4 Keras

There are many ways touse deep learning algorithms. One fine way is building CNN [2] models since it provides high level of performance on multiple types of dataset. To build a CNN [2] model Keras [13] works as the backbone of a model as it works in the backend together with TensorFlow [15]. Keras [13] is written in python which is considered an application programming and library function of CNNs [2]. Keras [13] not only supports Convolutional neural network but also recurrent neural network. Keras [13] can run on both GPU and CPU without compromising the quality. Keras [13] serves a several

number of applications to use the common neural network to build the layers, activation functions, several intentions, optimizations and tools.

3.3 Data Collection Procedure

Dataset is a collection of essential text, image, numerical, questionnaires or any form of data on which the proposed is applied on and executed by the researchers. So, to acquire an accurate output and to determine or declare a numerical or analytical result dataset is a must prerequisite for any research work. In this research work, CNN [2] and image processing methods are intended to administrate on our individually collected raw dataset.

We have assembled about 6,000 leaf and flower images from various sponge gourd with the help of android phones and digital cameras to distinguish the diseases to carry out the proposed idea. To attain the best accuracy by using CNN [2], vast amount of data is a must. So, we have built our own dataset of sponge gourd leaves and flower according to the need of our proposed model. Some sample images of our collected raw dataset are shown below in Figure 3.2.

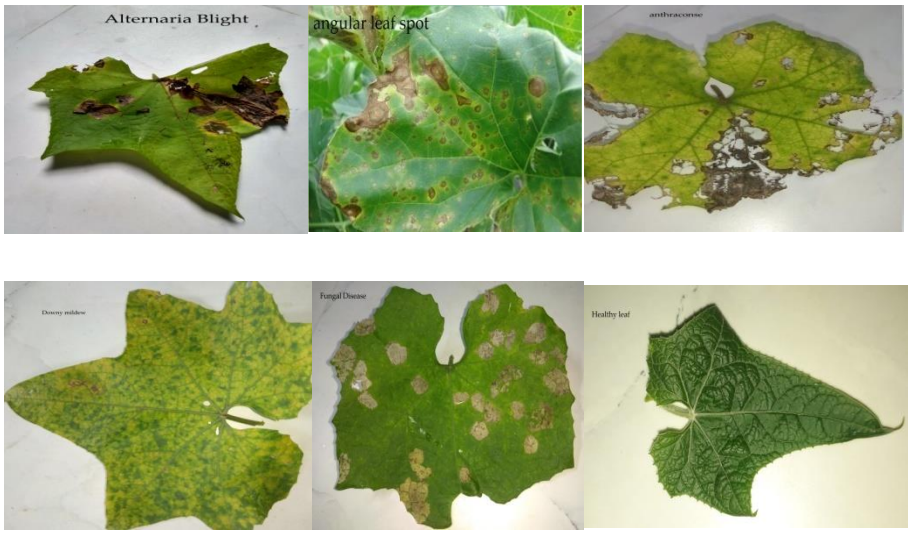


Figure 3.2: The collected dataset

3.4 Statistical Analysis

In this research work we plan to detect 4 leaf diseases of sponge gourd along with a healthy class and also the delicate flowers as well as the fresh flowers. We have allowed .jpg, .gif, .bmp image formats in this research work.

- Downy mildew
- Alternaria blight
- Anthracnose
- Healthy leaf
- Unhealthy flower and
- Healthy flower

Downy mildew: Downy mildew is an ailment of fungal which is responsible for distortion of leaves, stems and flowers. Four kinds of species can be found for downy mildew and they are Peronospora, Bremia, Plasmopara, Basidiophora. Members of the oomycete genus Sclerospora are censurable for this disease of downy mildew. A downy growth with angular spores can be seen on plant surface or underneath of leaves and this spore stretch out on the leaves as like as spatter of water.

Fungal disease: The biggest number of plant and leaf pathogen formed by fungi and around 85% plant diseases caused by fungal or fungal like organism. By slaying the cells, fungi wreck the plants. Infected seed, crop debris, soil, nearby crops and weeds are the

common area in where fungi can easily and mostly can affect. There have some fungal diseases which mostly effect on vegetables, they are Botrytis rots, Fusarium rots, Rusts, Sclerotinia rots (white mold), Rhizoctonia rots, Clorosis(Yellowing of leaves) and etc.

Alternaria blight: The name fungus as '*Alternariacucumerina'* is censurable for the disease of Alternaria blight. The first symptom emerged on the very mature leaves near the plants crown as a very small spots like brown to black oval bruise. Normally the color of lesion become gray but by the aggrandizing of this lesion, it become dark black and sunken and finally the petioles and stems clasped and plant dies.

Anthracnose disease: Anthracnose disease invades all parts of the plant at any growth stage. Symptoms are most visible on the leaves and ripe fruits. At first, anthracnose usually appears in the leaves as small and irregular yellow, brown, dark-brown or black spots. The spots can expand and merge to cover the entire affected area. The color of the affected part becomes darker with age. The disease can cause cancer in the petioles and on the stalks, causing severe deflation and digestion of the fruit and roots. Infected fruits have small, watery, submerged, round spots.

Angular leaf spot: Angular leaf spots disease symptoms can vary depending on the plant variety, weather conditions, and time of year. Spots close together can join to form large areas of dead leaf tissue, giving plant blotchy appearance. In the spots, dead leaf tissue can be cut out.

The statistical calculation of our collected dataset is described in Table 3.1.

TABLE 3.1: STATISTICALEVALUATIONOFCOLLECTED DATASET

Disease Name	Collected data (number of image)
Downy Mildew	972
Fungal Disease	617
Alternaria blight	366
Angular leaf spot	182
Anthracnose	710
Healthy leaf	1208
Healthy Flower	624
Unhealthy Flower	259

3.5 Implementation Requirements

3.5.1 Image Pre- Processing

Our collected raw dataset has been breached into two individual section asserted as test and train. We have put 20% image data in the test folder and 80% image data in the train folder.

All assembled raw images have been processed and resized into (256*256) pixels without compromising their aspect for pre-training them bestow to our proposed method.

3.5.2 Model Design

Every element used to design, create, visualize the proposed methodology in this research experiment is briefly described in this section.

3.5.2.1 Convolutional Neural Network

CNN [2] model architecture has been enforced to achieve substantial accuracy. CNN [2] model architecture is a vast part of deep learning algorithm in which input images are trained and tested by passing through a sequential series of convolutional layers with

paramount filters. Minimal number of image processing is required for the fasten computation process to work with CNN [2] algorithm. In this research, CNN [2] algorithms have evaluated the visual imageries for assuring higher qualities to process the images.

A CNN [2] model always endorsed an input and an output layer. Our proposed model consumed multi-layers CNN [2]. RGB (Red, Green, Blue) color model is consumed for the images in this research. Since, our proposed CNN [2] model used multi-layer, there are multiple layers of convolutional layer as convolutional 2D. The arrangement of the proposed CNN [2] model is shown below in Table 3.2.

TABLE 3.2: OUR PROPOSEDMODEL

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 256, 256, 64)	12352
conv2d_2 (Conv2D)	(None, 256, 256, 64)	262208
max_pooling2d_1 (MaxPooling2)	(None, 128, 128, 64)	0
conv2d_3 (Conv2D)	(None, 128, 128, 32)	51232
conv2d_4 (Conv2D)	(None, 128, 128, 32)	25632
max_pooling2d_2 (MaxPooling2)	(None, 64, 64, 32)	0
batch_normalization_1(Batch)	(None, 64, 64, 32)	128
conv2d_5 (Conv2D)	(None, 64, 64, 16)	12816
conv2d_6 (Conv2D)	(None, 64, 64, 16)	6416
max_pooling2d_3 (MaxPooling)	(None, 32, 32, 16)	0
conv2d_7 (Conv2D)	(None, 32, 32, 8)	1160
conv2d_8 (Conv2D)	(None, 32, 32, 8)	584
max_pooling2d_4 (MaxPooling)	(None, 16, 16, 8)	0
batch_normalization_2(Batch	(None, 16, 32, 8)	32
flatten_1	(None, 2048)	0
dense_1 (Dense)	(None, 512)	1049088

3.5.2.2 Activation Layer

Activation layers basically emulates the fired neurons of human brain. Activation layers sway the passing signals from one layer to another and the output signal is intensely linked to the previous layer's signal. Convolutional Neural Network (CNN) [2] suited to various activation layers. Following this path, multiple ReLU [18] (Rectified Linear Unit)

activation function is used in this proposed methodology. ReLU [18] ensures the fasten momentums of training dataset by the machine and it executes threshold operation on every element of input.

$$f(x) = \begin{cases} x, & x \geq 0 \\ 0, & x < 0 \end{cases} \dots\dots\dots\dots\dots\dots\dots\dots (i)$$

3.5.2.3 Pooling Layer

Maxpooling [19] 2D is used in this research to convert the image matrix in a shorten matrix. In general, maxpooling layer [19] sums up the average appearance of a feature and the most activated appearance of a feature respectively. Pooling layers accompany the CNN [2] layers for down-sampling to remove the connections of the acquainted layers. Maxpooling layer [19] serves value with names and assists to reduce the overfitting [22] issue. Figure 3.3 shows the backend work of a MaxPool layer.

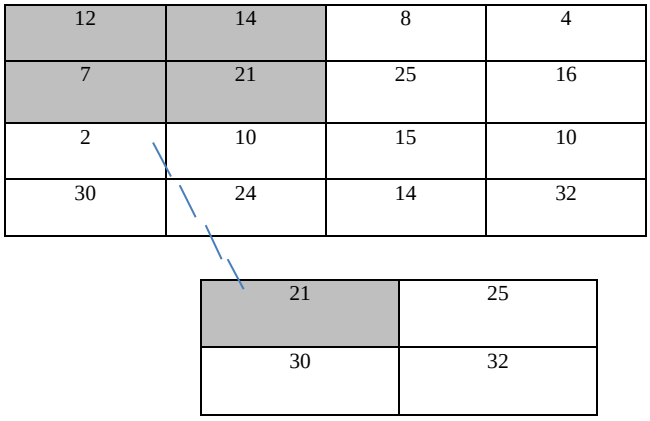


Figure 3.3.: MaxPool layer

3.5.2.4 Fully Connected Layer

CNN [2] blindly follows the brain and neurons connection model. All the networks and layers in CNN [2] are interconnected with each other in such a way that the outcome of the previous layer counted as the input value in the next layer and in this way, CNN [2] is

the completely connected network to the latest layer of its Figure 3.4 below shows a fully connected [20] CNN [2] layer.

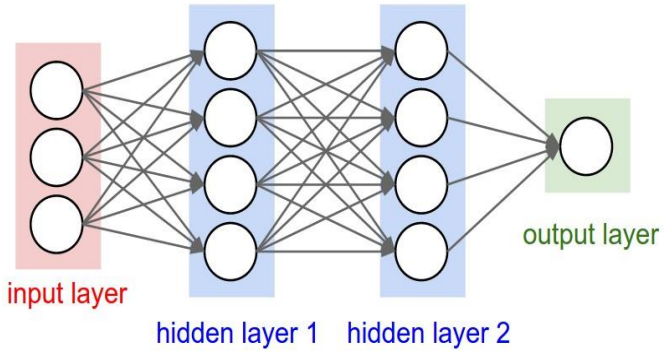


Figure 3.4: Fully connected layer

Layers between input and output layer are known as "Hidden Layers" and it is a bit tough to know or guess how the hidden layers work. There can be one or multiple fully connected layers [20] in one CNN [2] model. For creating a fully connected layer [20] in CNN [2], "fullyConnectedLayer" function is used. Name, value, Output Size etc are the main parameters of a fullyConnectedLayer function in CNN [2] algorithm.

3.5.2.5 Other layers

In this proposed CNN [2] model, to activate the layers, batch normalization [21] is used. The first layer contains (256,256,3) input shaped, (64× 64) filters, (8×8) kernel, (1×1) strides and same "padding". Every layer followed the same formation.

$$ReLU(X) = MAX\ (0, X) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (ii)$$

Dense layer has followed the flatten layer using 50% of dropout. Last output layer has used 17 units with activation SoftMax and sigmoid.

$$\sigma(Z) = \frac{e^{zj}}{\sum_{k=1}^{k} e^{zk}} for\ j = 1, \dots\dots, k\ \dots\dots\dots\dots\dots\dots\dots (iii)$$

$$\varphi(Z) = \frac{1}{1 + e^{-z}} \ldots\ldots\ldots\ldots\ldots\ldots (iv)$$

3.5.2.6 Adam Optimization Algorithm

In deep learning models, using of optimization algorithms can mean the differences between good results. Stochastic gradient descent has an extension naming "Adam Optimization Algorithm" [16]. Deep learning models have paved the broader way for the uses of Adam algorithm [16] in recent days. CNN [2] models, some image processing methods, natural language processing systems are using this Adam algorithm [16] for reducing the error rates. In his research, Adam algorithm [16] has been used to update the network weights iterative based training data and to reduce the learning rate. The value of Adam [16] is taken as 0.001. The graphical comparison between different optimization algorithms is shown below in Figure 3.5.

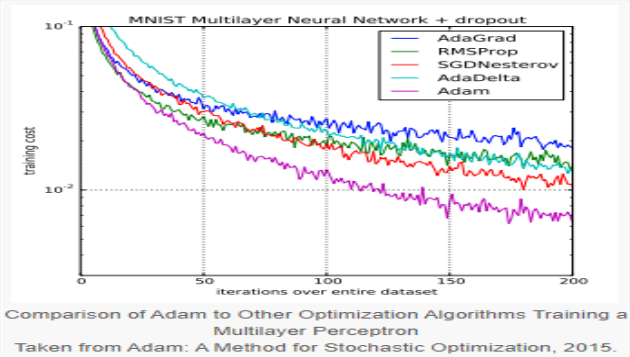


Figure 3.5: Comparison between different optimization algorithms

3.6 Image Enhancement

The dataset is artificially inflated by the image enhancement method. In this research image enhancement is used to segregate the raw images into several augment. Image enhancement is used as given below in this research work:

- Lessening complexity exhibition of an image.
- Facilitating and fluctuating the representation of an image.
- Generating a considerable dataset by producing various shapes and angle from an image.
- For assuring the highest accuracy, our proposed model used image rotation in range with the value of 40, width shift and height shift in the range with the value of 0.2, rescale as 1/155, shear and zoom in the range with the value of 0.2. Horizontal flip as True and fill mode as Nearest is augmented in the proposed model for finding the highest accuracy. All the necessary image augmentation is shown in Figure (a), (b), (c), (d), (e), (f), (g), (h), (i) and (j) below in Figure 3.6.

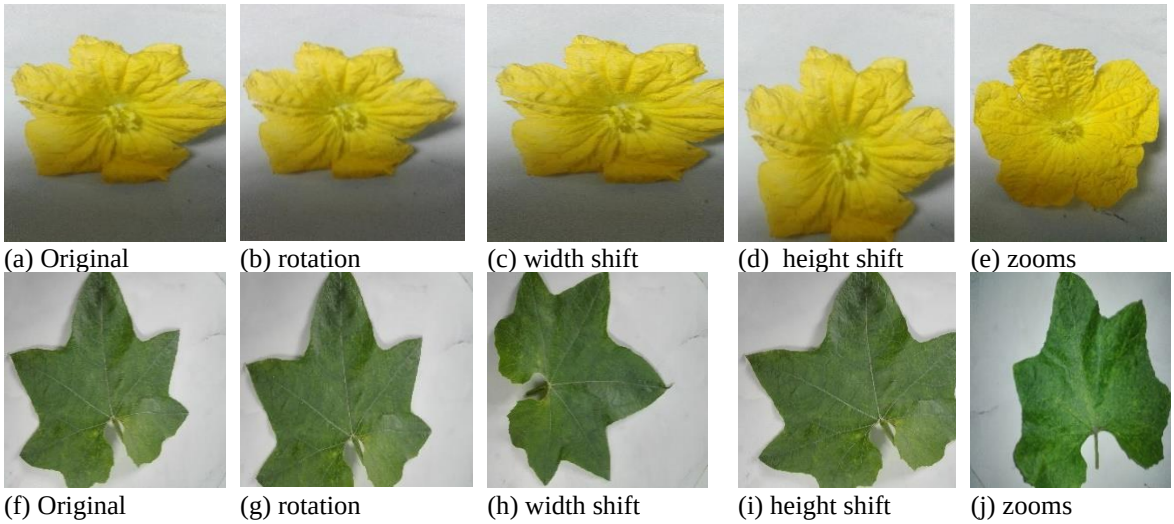


Figure 3.6: Image Enhancement

CHAPTER 4
EXPERIMENTAL EVALUATION

4.1 Introduction

To gain better accuracy and performance, machine learning needs a large amount of training information. The larger the dataset is, the higher is the accuracy. The combinations of images artificially generate an image using different processes such as rotation, shear, zoom, Hight shift, width shift etc. Where we used total 4938 data. To create a strong image classifier in this research we are using 80% as training data and 20% as test data from the total collected raw dataset. First of all, we have divided the dataset according to different disease image sample from the internet. We have identified 5 disease: Downy mildew, Fungal Disease, Alternaria blight, Angular leaf spot, Anthracnose. Where Downy mildew has 972 images, Fungal Disease has 617 images, Alternaria blight has 366 images, Angular leaf spot has 182 images, Anthracnose has 710 images. Apart from this we have divided healthy images into healthy leaf, healthy flower, unhealthy flower class. Healthy leaf has 1208 images, healthy flowers has 624 images and unhealthy flower has 259 images. To train the machine, we have used 3980 images and 987 images for validation. Our dataset is named as “Dhundol_final_data”.

4.2 CNN Model Implementation

AlexNet [14] is a kind of [2]. For designing the visual figure of our proposed CNN [2] model, we have used AlexNet [14]. AlexNet [14] uses total number of 8 layers in which first 5 layers are counted as CNN [2] layers following by Maxpool [19] and others are fully connected layers [20]. The basic Alexnet [14] model structure is given in Figure 4.1:

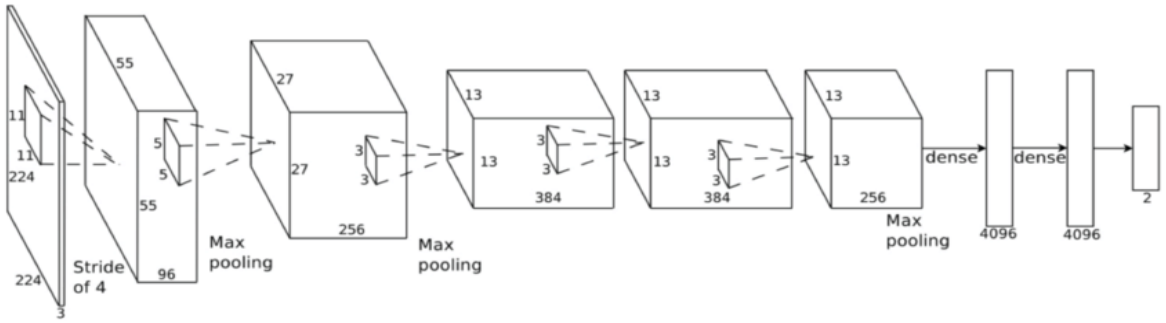


Figure 4.1: AlexNet Model Structure

The model architecture of our proposed CNN [2] model is given below in Figure 4.2:

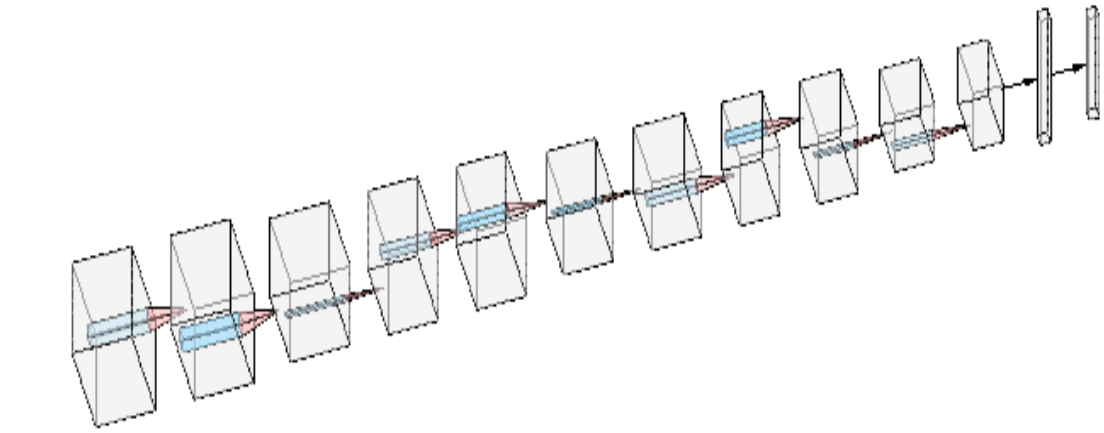


Figure 4.2: Model architecture of our proposed model

CHAPTER 5

RESULT AND DISCUSSION

5.1 Introduction

This section briefly exposes the practical findings of the studied dataset and the whole outcome of the complete research work. Both graphical and numerical or statistical explanation of our established model is disclosed in this section. How the model has worked during the research process and their output explanations are described without any biasness.

5.2 Experimental Result

5.2.1 Statistical Result

Table 5.1. explains how the iterative CNN [2] model worked after every epoch with accuracy, loss and error rate.

TABLE 5.1: EXPERIMENTAL STATISTICAL RESULT

Epoch	Training loss	Training accuracy (%)	Validation loss	Validation accuracy (%)	Learning rate reduce
1/30	1.8719	31.98%	2.2828	25.73%	
2/30	1.5896	38.24%	1.6708	36.37%	
3/30	1.4984	43.65%	1.6365	39.27%	
4/30	1.4715	43.05%	2.4848	34.89%	0.0002000
5/30	1.4109	45.90%	1.3748	43.86%	
6/30	1.3759	46.32%	1.3687	43.32%	4.0000002
7/30	1.3698	46.80%	1.3453	44.87%	
8/30	1.3547	47.39%	1.3643	43.33%	8.0000005
9/30	1.3406	47.64%	1.3166	45.68%	
10/30	1.3387	47.98%	1.3468	42.58%	1.6000002
11/30	1.3481	47.04%	1.3216	44.80%	1e-06
12/30	1.3442	47.36%	1.3640	42.91%	
13/30	1.3440	47.36%	1.3090	45.34%	
14/30	1.3526	47.46%	1.3362	43.93%	
15/30	1.3449	47.26%	1.3327	44.13%	
16/30	1.3446	47.26%	1.3348	44.26%	
17/30	1.3403	47.20%	1.3513	42.31%	

18/30	1.3483	47.82%	1.3283	45.14%	
19/30	1.3378	48.06%	1.3139	45.21%	
20/30	1.3399	47.82%	1.3465	42.98%	
21/30	1.3428	47.22%	1.3191	45.14%	
22/30	1.3466	46.95%	1.3390	43.27%	
23/30	1.3391	46.95%	1.3245	44.67%	
24/30	1.3483	47.40%	1.3337	43.72%	
25/30	1.3494	47.00%	1.3120	44.06%	
26/30	1.3456	47.15%	1.3279	46.09%	
27/30	1.3279	47.59%	1.3567	42.91%	
28/30	1.3461	47.09%	1.3078	44.13%	
29/30	1.3382	47.30%	1.3430	43.72%	
30/30	1.3382	47.74%	1.3322	44.07%	

5.2.2 Accuracy graph

Statistical explanations of a research are usually condoned by the accuracy graph. Precession of the accomplished numeric values or statistical explanations of an output is checked by the model accuracy graph. The accuracy graph of this research model displays that the uppermost graph of training and validation loss faced no issues of underfitting or overfitting [22]. Following the first graph the lower graph is displaying the and training and validation accuracy after the closing epoch and it also does not has no issues of noises. The accuracy graph of the proposed model is shown below in Figure 5.1.

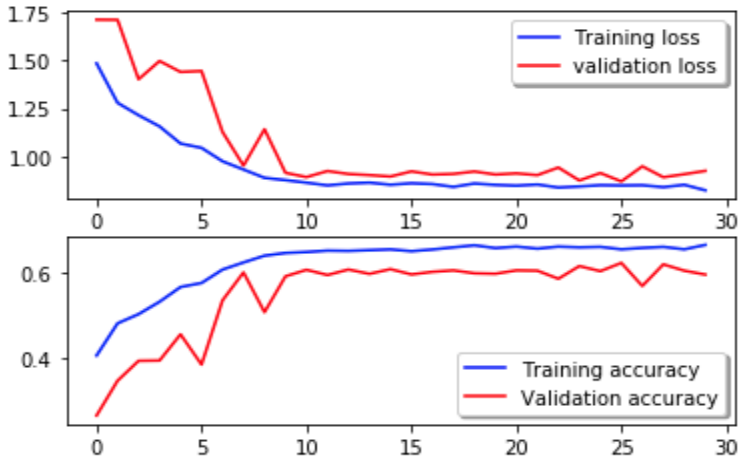


Figure 5.1: Accuracy graph

5.3 Descriptive Analysis

The classification report is an extreme table of precision indicating the performance of our proposed model on test dataset from where we obtain the (True values, Accuracy, Precision, Recall, F1 score) [23] can be easily uncovered by reviewing a confusion matrix of any research.

5.3.1 Accuracy

Accuracy is a performance measure which is a ratio of accurately predicted observation from the overall observation.

$$Accuracy = \frac{TP + TN}{TP + FP + FN + TN}$$

5.3.2 Precision

Precision is the measure of accurately determined positive events from the overall predicted positive events.

$$Precision = \frac{\mathrm{TP}}{\mathrm{TP} + \mathrm{FP}}$$

5.3.3 Recall

Recall is the measure of accurately determined positive events from the actual positive events.

$$Recall = \frac{\mathrm{TP}}{\mathrm{TP} + \mathrm{FN}}$$

5.3.4 F1 Score

F1 Score is an overall measure of accuracy that includes both precision and recall. It's the weighted average of both Precision & Recall.

$$F1\ scores = 2 * \frac{\mathrm{Recall} * \mathrm{Precision}}{\mathrm{Recall} + \mathrm{Precision}}$$

$$TPR/Sensitivity = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

$$Specificity = \frac{\text{TN}}{\text{TN} + \text{FP}}$$

$$FPR = 1 - \text{Specificity}$$

$$= \frac{\text{FP}}{\text{TN} + \text{FP}}$$

The classification report of our proposed methodology according to these formulas is given in Table 5.2.

TABLE 5.2: CLASSIFICATION REPORT

Disease	precision	recall	F1-score	support
Alternaria blight	0.37	0.36	0.37	263
Anthracnose	0.72	0.39	0.51	563
Downy mildew	0.46	0.77	0.58	250
Healthy	0.77	0.91	0.83	419
Healthy flower	0.55	0.97	0.71	195
Unhealthy flower	0.88	0.30	0.45	189
accuracy			0.60	1879
Macro avg	0.63	0.62	0.57	1879
Weighted avg	0.65	0.60	0.58	1879

5.4 Confusion Matrix

Confusion matrix [24] portrays the performance of the proposed classification model. The confusion matrix [24] of this research work describes how accurately accurate our proposed model works. The proposed model of this research is working smoothly as all the diagonal values of (6×6) matrix is larger than other values. The confusion matrix [24] shown in Figure 5.2.

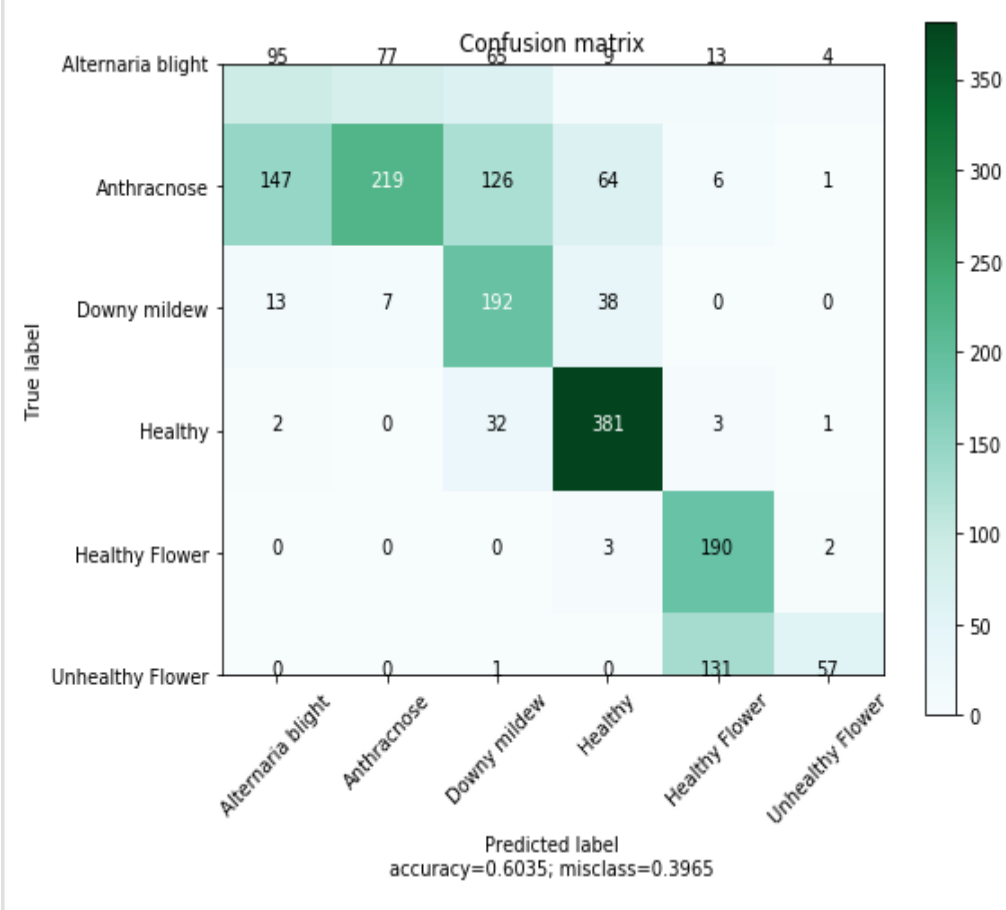


Figure 5.2: Confusion Matrix

5.5 Layer visualization:

Layer visualization [25] of a CNN [2] model displays the feature maps that are the output given by the CNN [2] model layers as well as different pooling layers and batch normalization. It shows the data structure processes inside a CNN [2] network. Layers of a CNN [2] can be obtained in different shapes and sizes such as circle, square, trigonal etc. Figure 5.3, 5.4, 5.5 show the different shapes of layer visualization [25] of a CNN [2].

Figure:5.3: Square layer visualization

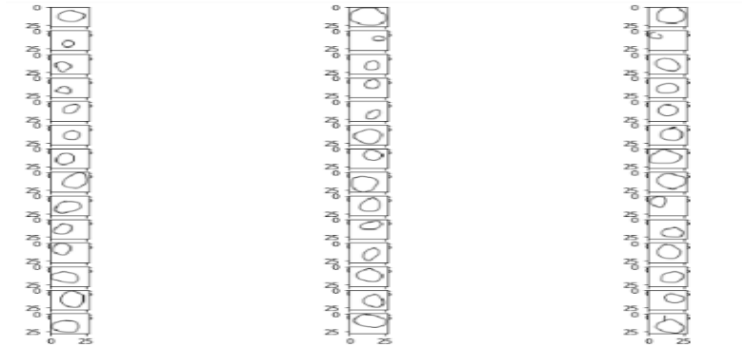


Figure:5.4: Circle layer visualization

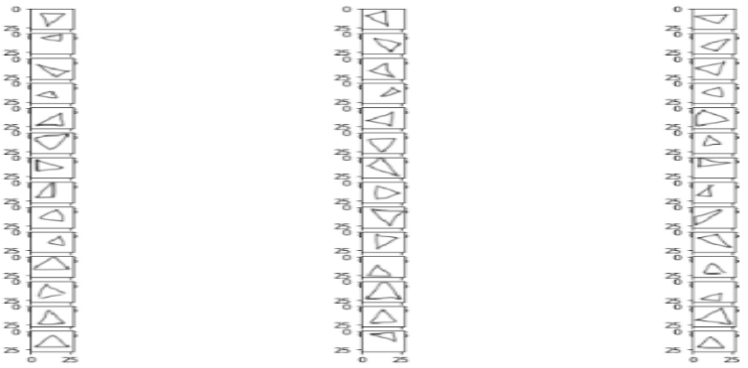
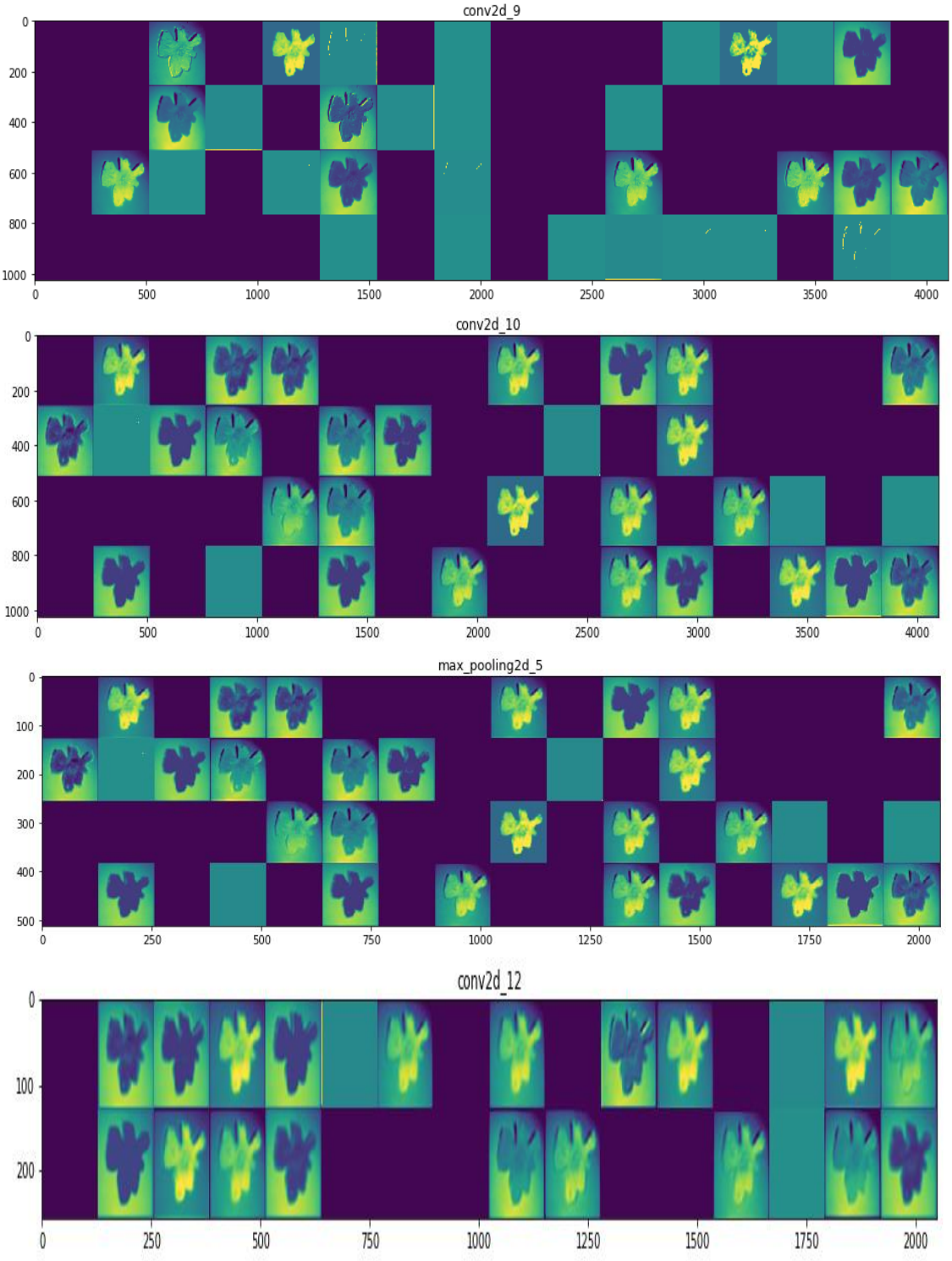


Figure:5.5: Trigonal layer visualization

In this research work, we have used square layer visualization [25] by adding MaxPool layer, Batch normalization [21], SoftMax, Dense along with CNN [2] layers for better

visual displays. Figure 5.6 below shows every working CNN [2] layers inside the network with a real time visual outcome.



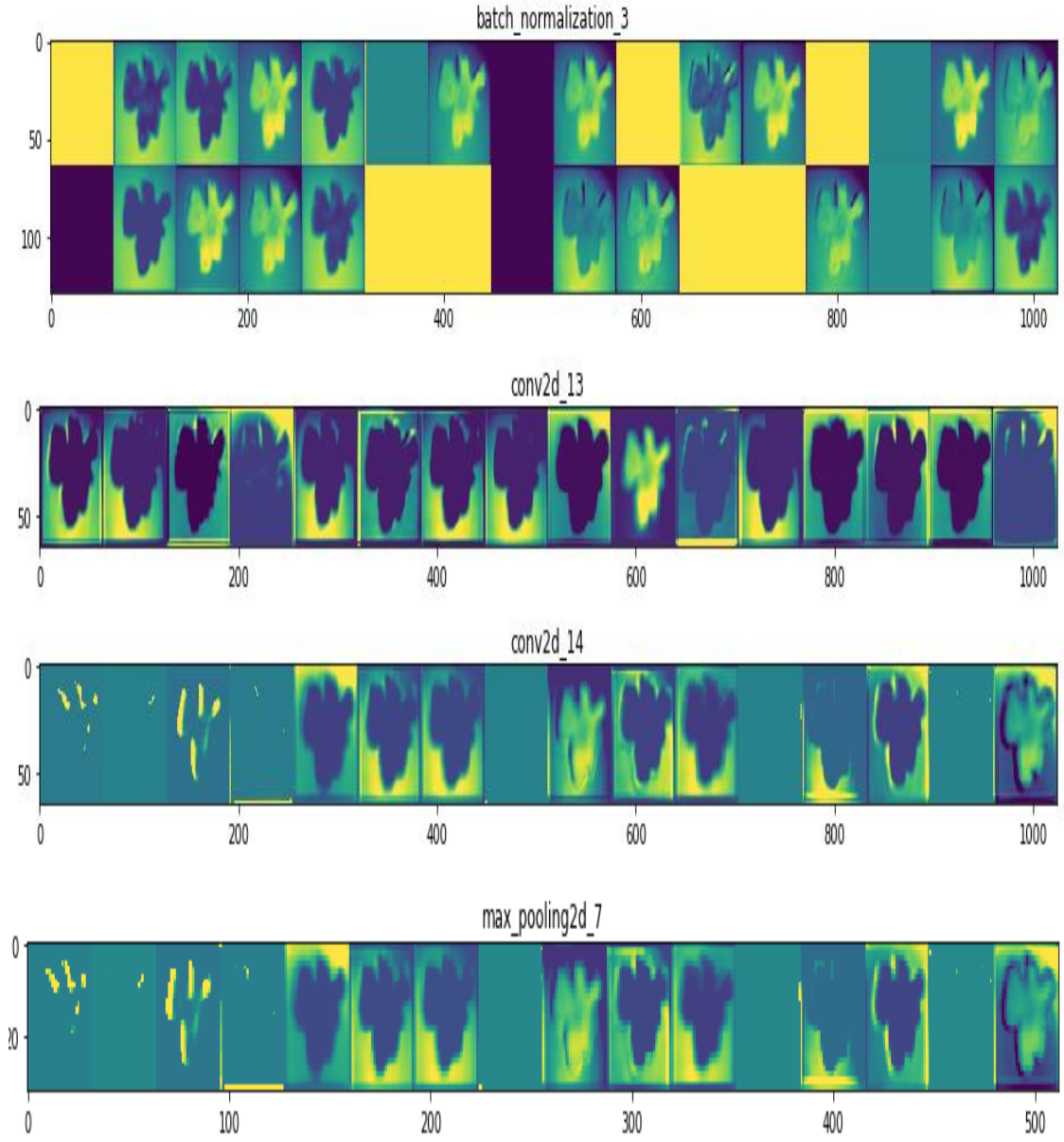


Figure:5.6 Layer Visualization

5.6 Summary

Diseases detection is one of the most hurdle part of any cultivation. From ancient time, various methods to predict the disease of crops, fruits and vegetables have been applied on. With the invention of new methods and forms ranchers hope to get a better result in

detection process. So, to detect the vegetables diseases (Sponge Gourd) we have studied and applied the newest technology of deep learning method, CNN [2]. From the obtained outcome of the experiment, it confirms that the CNN [2] model we have used has worked very well and given a higher accuracy on trial stages on our raw dataset. We have tried to provide all the necessary information with both numerical and graphical explanation for mass people to gather a clear vision about the model and our research which we hope will be beneficial for all.

CHAPTER 6

CONCLUSION
&
IMPLECATION FOR FUTURE RESEARCH

6.1 Summary of the Study

In this research paper, we have applied CNN [2] model to detect the leaf and flower diseases of sponge gourd for the commercial cultivation in Bangladesh. We have conducted sequential model of supervised neural network learning along with AlexNet [14]. These models have been implemented on about 6000 images of 6 classes which are: Downy mildew, Alternaria blight, Anthracnose, Healthy leaf, Unhealthy flower and Healthy flower and we have succeeded to achieve a high accuracy of 66.63%.

6.2 Limitation and Conclusion

An ingenious idea has been introducing in this research to develop, improve and upgrade our raw food industry both locally and globally. This research targeted to help the native ranchers by enlightening the biggest problem of disease detection in commercial sponge gourd cultivation.

We have a small dataset for our research since every image was collected from scratch and to collected more image data of sponge gourd was really hard for us. We could have applied more models of CNN [2] on our experiment such as MobileNet, ResNet, Xceptionetc but for the limited dataset we could not achieved to allow these models in this research work. Some Related work on different vegetable and plants have got more high accuracy since their dataset was labeled more accurately by the professionals. Comparing the collected raw images of our dataset with the internet images was a bit risky process for us since labeling can give some inaccurate results.

Nowadays advanced countries are implementing CNN [2] and image processing algorithms to make different disease prediction software and application for vegetables and crops. In this research our proposed model of CNN [2] and image processing has exhibited its ability to detect the diseases ensuring the most accurate process. Thus, we are hoping that native ranchers as well as agricultural experts in Bangladesh will have faith in our system and broaden the agriculture sector with the help of latest technology. We are hoping to see the sponge gourd name in export vegetables list in near future over its commercial cultivation.

6.3 Implication for Further Study

Since mobile technology is way more available in our country following this path, we plan to manufacture a software and an android application in "Bengali" language for the rural farmers having no knowledge in other language except Bengali. We want to create a software that can easily identify the vegetable diseases and accurately predict them for the ranchers. When a farmer clicks a picture of a diseased leaf, flower or vegetables area, our software can predict which disease has attacked there and provide an instant solution. We plan to apply this same method and models on many more local vegetables of Bangladesh in future so that these neglected but enriched local vegetables receive a position of their own in the market place.

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APPENDICES

Abbreviation& Acronym:

CNN = Convolutional Neural Network

ReLU = Rectified Linear Unit

SDG = Sustainable Development Goal

Sample of our Dataset:

Alternaria Blight:




Anthracnose:

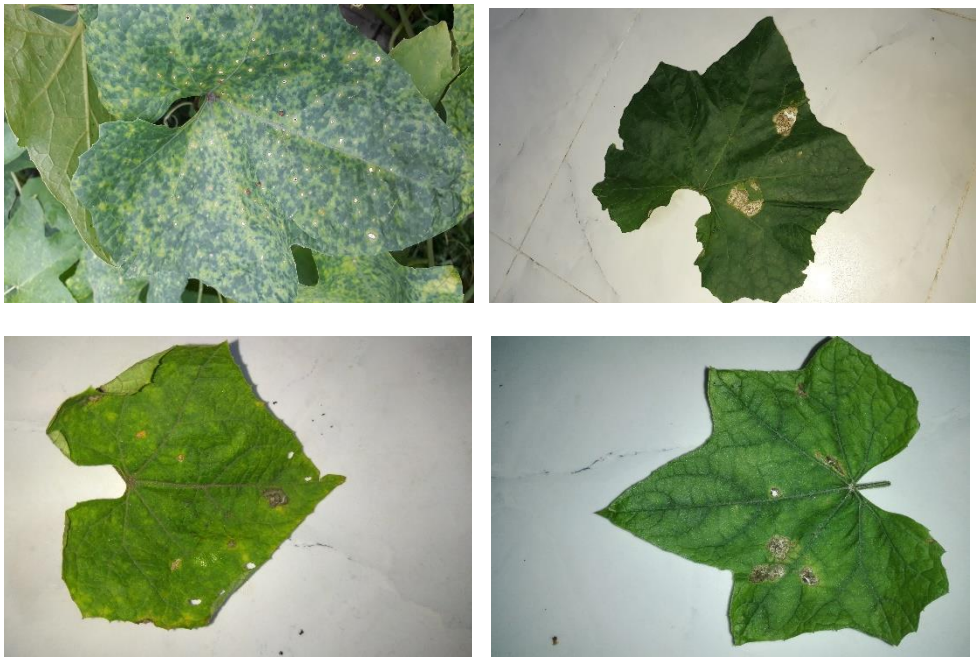



Angular Leaf Spot:



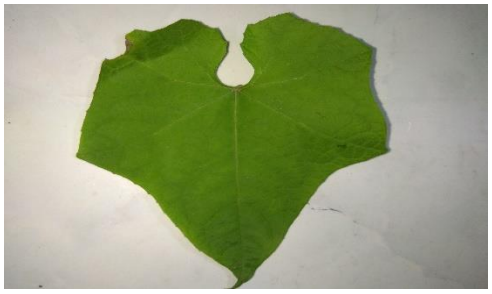

Downy Mildew:

Fungal Disease:



Healthy Leaf:






Unhealthy Flower:




Healthy Flower: