

CROP DISEASE DETECTION USING COMPUTER VISION

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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/internship titled “**Crop disease detection using computer vision**”, submitted by Md. Jobaer Ahmed, ID No: 161-15-6735 and Shahriya Siddique, ID No: 161-15-7234 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 05 December, 2019.

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DECLARATION

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

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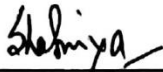


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ABSTRACT

Historically, Bangladesh is an agriculture-based country. Approximately 40% of its population is involved in the agriculture sector. Although our country has achieved food sufficiency in recent years and many of the obstacles in farming has been removed due to the emerging of modern technology, the farmers in the rural area are still suffering from multiple issues that are harming the harvesting of the crops. The various diseases of the plants and crops are among them. A tremendous amount of product damage due to diseases. It has a bad impact on the farmer as well as a bad effect on our economy. This occurs due to not to able to detect disease in time. If the disease can detect at the earliest time, it is possible to decrease the damage rate. It is tough and arduous to detect these diseases manually. In this project, we have taken various methodologies to identify disease. We have gathered a database based on different images of disease of potato and tomato to train and test. We have used PyTorch library which has developed by Facebook deep learning team. We also have used Torchvision for image segmentation and ResNet 152 for training our dataset. It helps to identify disease type. This model has a precise excessive perspective to be further enhanced in the future.

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CHAPTER 1

INTRODUCTION

1.1. Introduction

Agriculture is an important factor in the growth of each country. It acts a dynamic role in the economy of the country. Bangladesh is primarily a cultivated country where the farming part plays a major part in accelerating financial growth. It is thus significant to have a gainful, supportable and eco-friendly cultivated system in order to confirm long-standing food safety for society. The comprehensive agriculture part has been specified the maximum precedence in order to sort Bangladesh self-supporting in food.

The purpose of our work is in agriculture is to raise efficiency and food excellence at compact expenses and through improved revenue as in Bangladesh, the maximum of the people relies on agriculture-based work. We produce several types of crops in our country. Among these potatoes and tomatoes are a more and more regular and consumable meal or nutrition in our country.

1.2. Motivation

Our country's economy, directly and indirectly, relies on agriculture-based work. A tremendous amount of people are depending on this sector in different ways. It is very significant for all kinds of people related to this sector to rise farming production. So their works need to be more efficient and have to more and more careful about the method of cultivation. Besides, it also important to care about diseases related to the crops, how to prevent the disease, how to cure them in time. Currently, in our country potato and tomato are regular crops and are producing a lot. That's why we became interested to work on this field. And finally, this interest turned in motivation.

1.3. Expected Output

Expected outputs of our project shown below.

- ✓ Detect the diseases of potato & tomato in order to decrease the damage rate of production.

- ✓ Detect the diseases at early stage which will help to take necessary steps to prevent the diseases.
- ✓ Save time by detecting disease quickly rather than find the disease one by one (manually).

1.4. Report Layout

The resolution of this project is to establish a corroboration that displays the precise output from our hypothetical planned project. It displays the potato and tomato disease detection using image processing. This proposed report is associated with the research method, significant models, implementation and exploratory work of the projected structure.

CHAPTER 2

BACKGROUND

2.1. Introduction

Agriculture is one of the keys to the development of Bangladesh. According to statistics, almost 15% of GDP depends on agriculture. Along with other crops potatoes, as well as tomatoes, are exporting to other countries all over the world nowadays. Besides our country has an enormous amount of consumption of these crops. Different types of diseases are damaging the production of potato as well as tomato vastly. There are number of works regarding crops. Mainly these work focused on paddy and other regular crops.

2.2. Related Work

There are many works regarding different crops with different types of algorithms and techniques some of them are shown below in the tabular form.

Table 2.1: Comparison between other's works and our work

Contributors	Objective	Type of work	Experiment image	Segmentation	Classifier	Accuracy
Our work	10 diseases of Tomato & 3 disease of Potato	Detection	273	Torch vision	NA	97.1% (Potato) 91.3% (Tomato)
D Samanta et al. (2012)	Scab Disease of Potato	Detection	235	k-means clustering	NA	87.60%
Santosh Adhikari et al. (2018)	Tomato (Leaf)	Detection	520	NA	CNN	89%
Monzurul islam & P.Bhowmik (2017)	Potato (Leaf)	Detection	300	NM	SVM	95.0%
Sagar Vetal & R.S. Khule(2017)	Tomato(Leaf)	Detection	320	NM	Multi-class SVM	93.75%

MG Athanihar et al. (2016)	Potato (Leaf)	Detection	NM	k-means clustering	BPNN	92%
Batule et al. (2016)	Leaf (NM)	Recogniti on	NM	k-means clustering	NA	NA

2.3. Scope of the Problem

This section is involved here for more awareness and points are given below:

- Collection of image
- Classifying image according to diseases
- Noise on collected image

2.4. Challenges

The main challenge of our project is to collect disease images of potato and tomato. Because disease type is not the same every season. It seems difficult to collect a proper number of images for each and every disease. Besides, those data we are able to collect most of them were noisy. For noisy data, we had to give extra effort to remove the noise as much as possible. Besides, the quality of the collected images also created some problems. We had to overcome these problems to complete this project.

CHAPTER 3

DISEASES TYPES AND SYMPTOMS

3.1. Introduction

A large number of potato and tomato diseases are available in our country. These are the most common among all diseases. And mentioning these below in brief.

❖ Potato diseases

- Early Blight
- Late blight

❖ Tomato diseases

- Bacterial spot
- Early blight
- Late blight
- Leaf mold
- Two spotted spider mite
- Target spot
- Yellow leaf curl virus disease
- Mosaic virus disease

Details decussion of diseases of potato are given below.

3.2. Early Blight

This is a fungal disease. A fungal pathogen produces this disease named *Alternaria solani*. This pathogen mainly infects fruits and leaves of the Potato. This disease one of the common ones in our region [1].

Symptoms:

It first appears as tiny, rough to round black brownish spots on the leaves of the lower part. These spots may vary from a tiny point to a 0.12 inch in diameter. As the spots increase, they become constrained by leaf veins and take on an angulate form. First, in

the developing term, injuries on fresh, entirely expanded, juicy leaves may be longer – up to 0.5 inches in diameter – and may, because of the size, be tangled with its injury [1].



Figure 3.1: Leaves of potato effected by Early Blight.

3.3. Late blight

This is also a fungal disease. An oomycete produced this disease called *Phytophthora infestans*. This oomycete mainly infects leaves and fruits of the Potato [2].

Symptoms:

This disease damages tubers, stems and leaves. Pretentious leaves seem to scald as if burnt by hot water and ultimately decompose and dry out. When absorbing, leaves chance brownish or dark in color. When toxicities are still dynamic, spots seem on the bottom side of leaves covered in what appearances like flour [2].



Figure 3.2: Leaves of potato effected by late blight

Details decussion of diseases of potato are given below.

3.4. Bacterial Spot

This is affected by species named *Xanthomonas* .There are four kinds of this species. They are *X. gardneri*, *X. perforans* , *X. vesicatoria* and lastly *X. euvesicatoria*). It especially affects fruit and leaf which causes defoliation [3].



Figure 3.3: Leaves of tomato effected by Bacterial Spot.

3.5. Early Blight

This is one of the known tomato diseases, arising approximately each term wherever tomatoes are grown-up. It create problem on fruits, leaves. It is produced by *Alternaria solani*, fungal pathogen [4].



Figure 3.4: Leaves of tomato effected by Early Blight.

3.6. Late blight

This effects both potato and tomato. It is formed by *Phytophthora infestans*, which is an oomycete [5].



Figure 3.5: Leaves of tomato effected by Late Blight

3.7. Leaf mold

This is a fungal disease. It is produced by a non-obligate pathogen called *Passalora fulva*. This pathogen has limited host choice that merely infects tomatoes, mostly in greenhouses [6].



Figure 3.6: Leaves of tomato effected by Leaf mold

3.8. Two spotted spider mite

These mites are infrequent pests that can effect solemn damage to tomato during hot dry climate [7].



Figure 3.7: Leaves of tomato effected by two spotted spider mite

3.9. Target Spot

This is a fungal disease. It is produced by *Corynespora cassiicola*, which is a species of fungus familiar as a plant pathogen. This disease is similar to early blight [8].



Figure 3.8: Leaves of tomato effected by Target Spot

3.10. Tomato yellow leaf curl virus disease

This disease caused by a virus named tomato yellow leaf curl virus. It is the dangerous virus for tomato production [9].



Figure 3.9: Leaves of tomato effected by tomato yellow leaf curl virus

3.11. Tomato mosaic virus disease

A virus is responsible for this disease named tomato mosaic virus (ToMV). Its symptoms can be altered and hard to isolate from other known viruses [10].



Figure 3.10: Leaves of tomato effected by Tomato mosaic virus

3.12. Septoria Leaf Spot

A fungus is responsible for this disease named *Septoria lycopersici*. It is one of the damaging diseases of tomato leaves and is predominantly work for zones where damp, moist weather continues for lengthy times [11].



Figure 3.11: Leaves of tomato effected by Septoria Leaf Spot.

CHAPTER 4

RESEARCH METHODOLOGY

4.1. Introduction

Diagnosing the disease of crops has become the most difficult work for farmers. Farmers suffer a great loss as they are not diagnosed in the early stages. That's why a proper methodology needs to build which recognizes the disease. This will become helpful for farmers and also helpful to those who are not involved in agricultural work on the actual side rather do a small amount of agricultural work around the house. The mentioned system does some early works such as taking images, resizing the taken images, segmenting the images, etc. After that, we have used ResNet to train the machine about the disease. And finally, this could able to detect the disease when input comes to the machine. The proposed method is shown in the procedure chart below.

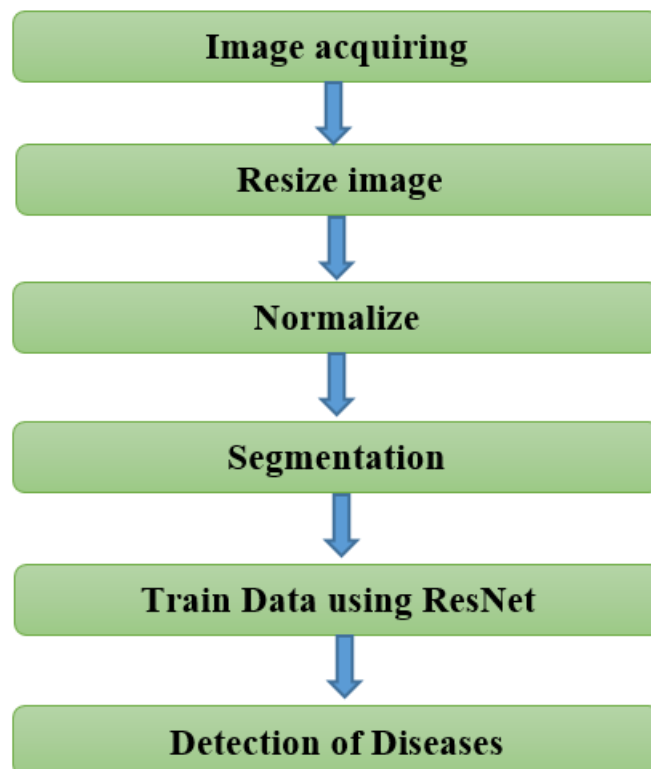


Figure 4.1: Flow Chart of the procedure

4.2. Research Subject and Instrumentation

Our project has built based on detecting several diseases of tomatoes and potatoes. For training the machine about the diseases we have used ResNet which is one of the popular architecture of CNN.

4.3. Data Collection Procedure

In our project, we detect plant disease by using PyTorch. Facebook AI group developed it. The image collection is an important portion of this project. We have collected images from several sources. But all disease images collected from the Internet. There are 38 types of disease on this dataset. But we select only 11 types of disease and the plant names are tomato and potato. The disease name is tomato Bacterial spot, Tomato Early blight, Tomato Late blight, Tomato Leaf Mold, Tomato Septoria leaf spot, Tomato Spider mites two-spotted spider mite, Tomato Target Spot, Tomato Yellow Leaf Curl Virus, Tomato mosaic virus, Tomato healthy, Potato Early blight, Potato Late blight, Potato healthy.

Table 4.1: Data Collection

NO.	Disease Name	Total train images	Total test images
1	Potato Early blight	314	63
2	Potato Late blight	303	69
3	Potato healthy	35	6
4	Tomato Bacterial spot	584	176
5	Tomato Early blight	285	73
6	Tomato Late blight	562	98
7	Tomato Leaf Mold	252	34

8	Tomato Septoria leaf spot	531	56
9	Tomato Spider mites two spotted spider mite	521	119
10	Tomato Target Spot	377	91
11	Tomato Yellow Leaf Curl Virus	1663	377
12	Tomato mosaic virus	111	32
13	Tomato healthy	495	65

4.4. Statistical Analysis

Convolutional Neural Network (CNN) is a class of deep neural networks, usually used for analyzing graphical images. CNN are state of the art models for Image Classification, Segmentation, Object Detection and several image processing tasks. In order to get started into the field of Image Processing or to improve the prediction accuracy of the custom CNN models, the knowledge of some of the famous CNN architectures will keep us reach the pace in this competitive and ravenous world. There are many CNN architectures available. Among these some popular architecture are given below.

- Xception Net
- Dense Net
- VGG Net
- Inception Net
- ResNet

Among these we have used ResNet in this project.

ResNet was an enormous part of computer vision in 2015 and is still enormously common. Hundreds or thousands of layers can be trained without a “vanishing gradient”. PyTorch lets you easily build ResNet models; it provides several pre-

trained ResNet architectures and lets you build your own ResNet architectures. ResNet is a CNN architecture which can sustenance hundreds or more convolutional layers. ResNet can add many layers with strong performance, while previous architectures had a drop off in the effectiveness with each additional layer.to implement ResNet we had to include Torchvision models. There are a number of layers in ResNet such as ResNet-18, 34, 50, 101 and 152. Among these, we used ResNet 152, where there are 152 layers that exist [12].

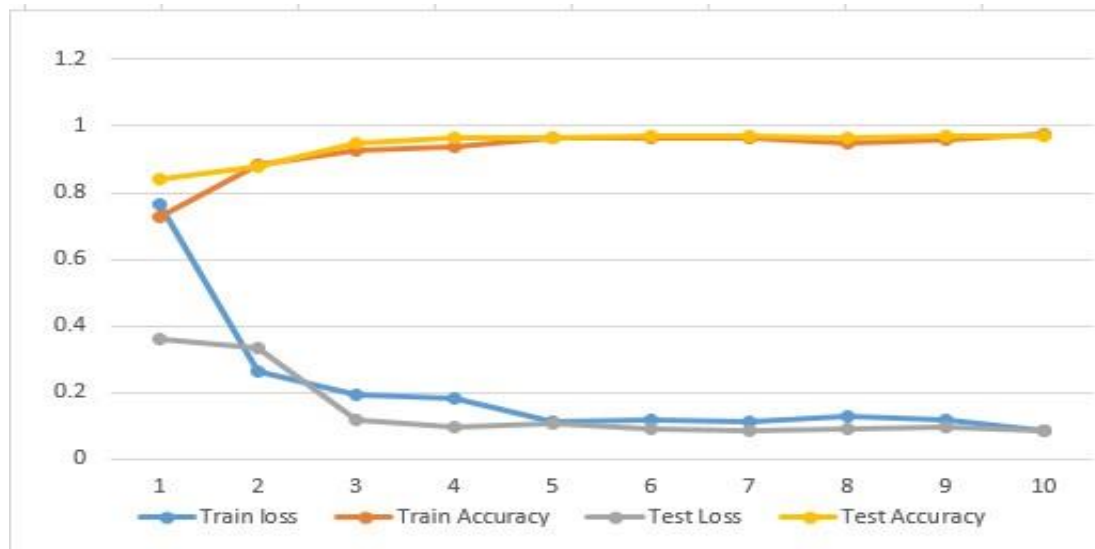


Figure 4.4: Accuracy VS Loss Line chart for Potato

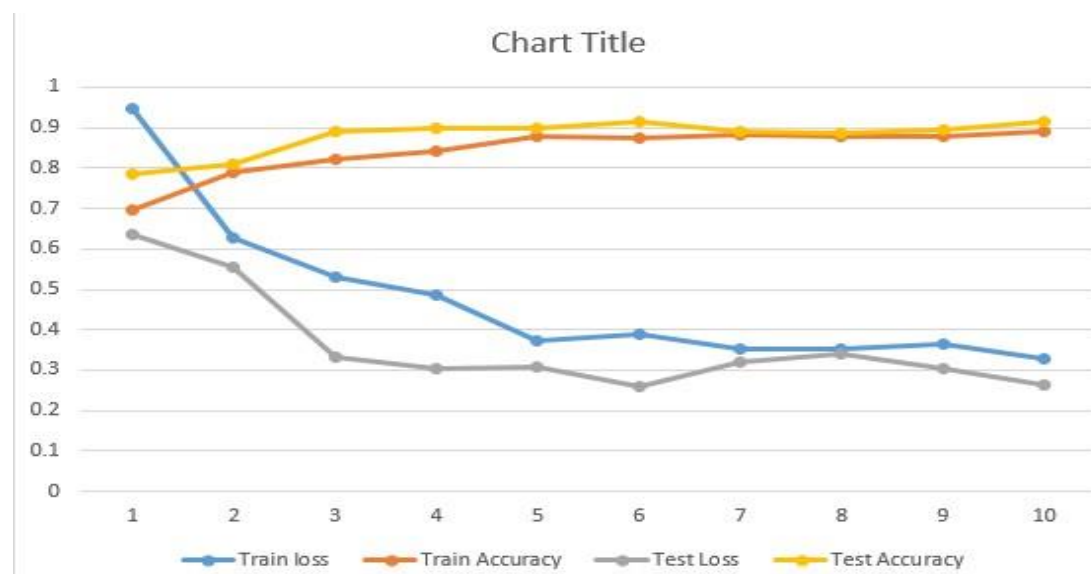


Figure 4.4: Accuracy VS Loss Line chart for Tomato

4.5. Implementation Requirements

To run our project we need some specific requirements that help us to implement this project. This requirement needed to full fill our project in the initial phases. To accomplish this, we had to use some hardware as well as some software.

Table 4.2: Software used in this project

Name of software	Details
Colab.research.google.com	For doing coding part
Windows 10 Pro	Operating system
Word	For writing project report
PowerPoint	For making presentation

CHAPTER 5

EXPERIMENTAL RESULTS AND DISCUSSION

5.1. Introduction

This chapter is about is discoursing about the execution of this project. It is about how we analyze the data such as Resizing images, segmenting images, etc. There is a table that shows what it looks like after segmenting the images. Besides, there is a Confusion matrix table available, as well as several line charts, which are also available.

5.2. Experimental Results

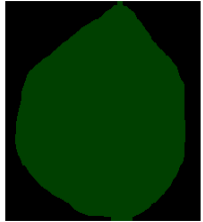
To gain experimental consequence we collect various kinds of potato images and tomato images and gathered them in a dataset. We collected these images data from different places such as field investigation, from the archive and also take from the internet for training and testing.

5.3. Descriptive Analysis

This section describes how we analyzed our collected images. We took photos of our subject through an ordinary camera. And then we had to crop these images, resize these images, etc. And finally, we had segmented these images. These procedures are shown in the table below with some example images.

Table 5.1: Processing of images including segmentation.

Disease name	Input	Resize size	Segmentation view	Outcome
Potato Early blight		[256,256]		Potato Early blight

Potato Late blight		[256,256]		Potato Late blight
Potato healthy		[256,256]		Potato healthy
Tomato Bacterial spot		[256,256]		Tomato Bacterial spot
Tomato Early blight		[256,256]		Tomato Early blight
Tomato Late blight		[256,256]		Tomato Late blight
Tomato Leaf mold		[256,256]		Tomato Leaf mold
Tomato Septoria leaf spot		[256,256]		Tomato Septoria leaf spot

Tomato Spider mites two spotted spider mite		[256,256]		Tomato Spider mites two spotted spider mite
Tomato Target Spot		[256,256]		Tomato Target Spot
Tomato Yellow Leaf Curl Virus		[256,256]		Tomato Yellow Leaf Curl Virus
Tomato mosaic virus		[256,256]		Tomato mosaic virus
Tomato healthy		[256,256]		Tomato healthy

5.4. Image Segmentation

Firstly, we have done some predefined work like resizing, cropping the collected images and then we segmented the images for further work. We have used Torchvision segmentation. The pre-trained networks existing from 'torchvision' were trained on the ImageNet dataset where each color channel was normalized distinctly. For both sets it need to normalize the means and standard deviations of the images to what the network expects. For the means, it's ' [0.485, 0.456, 0.406]' and for the standard deviations '[0.229, 0.224, 0.225]', calculated from the images. These values will shift each color channel to be centered at 0 and range from -1 to 1 [13].

5.5. Confusion matrix

Here, we have shown in figure 5.2(a) the confusion matrix for Potato Disease.

Prediction					
Actual		Potato Early blight	Potato Late blight	Potato healthy	Total
	Potato Early blight	60	2	1	63
	Potato Late blight	1	66	2	69
	Potato healthy	0	1	5	6
	Total	61	69	8	138

Total accuracy of Potato Diseases from the confusion matrix.

Now, we know,

$$\begin{aligned}
 \text{Accuracy} &= \frac{(TP + TN)}{\text{Total}} \times 100\% \\
 &= \frac{(TP + TN)}{(TP + TN + FP + FN)} \times 100\%
 \end{aligned}$$

So, total accuracy

$$\begin{aligned}
 &= \frac{(60 + 66 + 5)}{138} \times 100\% \\
 &= 94.93 \%
 \end{aligned}$$

Table 5.3: Accuracy for individual diseases of Potato.

Diseases Class	Value
Potato Early blight	97.10%
Potato Late blight	95.65%
Potato healthy	97.10%

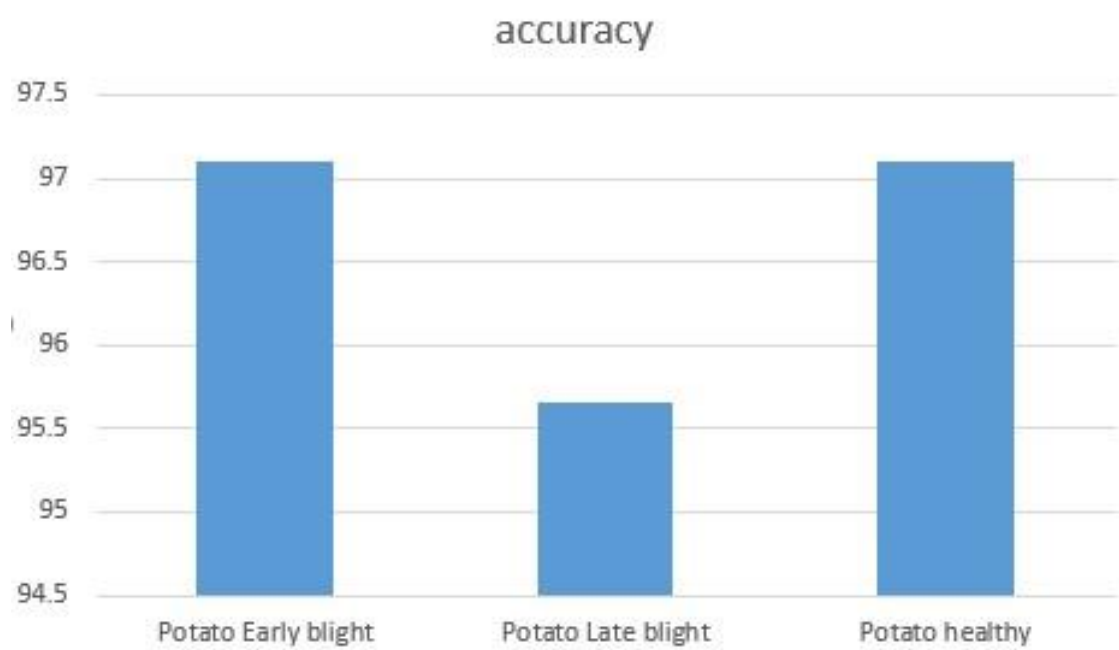


Figure 5.1: Accuracy for Potato diseases in Bar chart

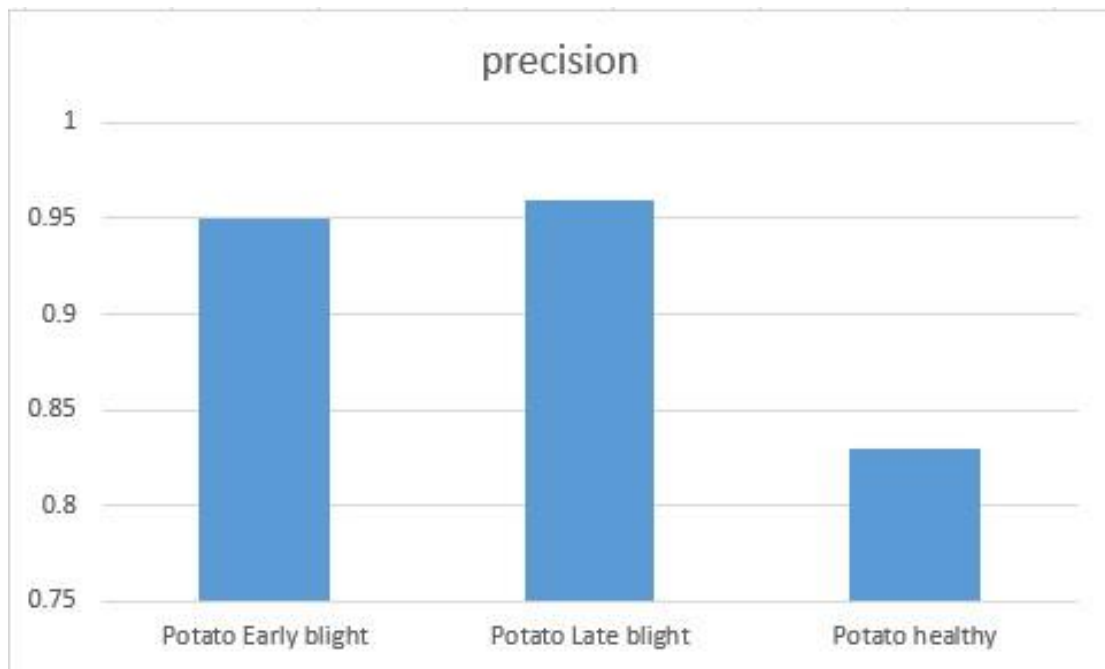


Figure 5.2: Precision for Potato diseases in Bar chart

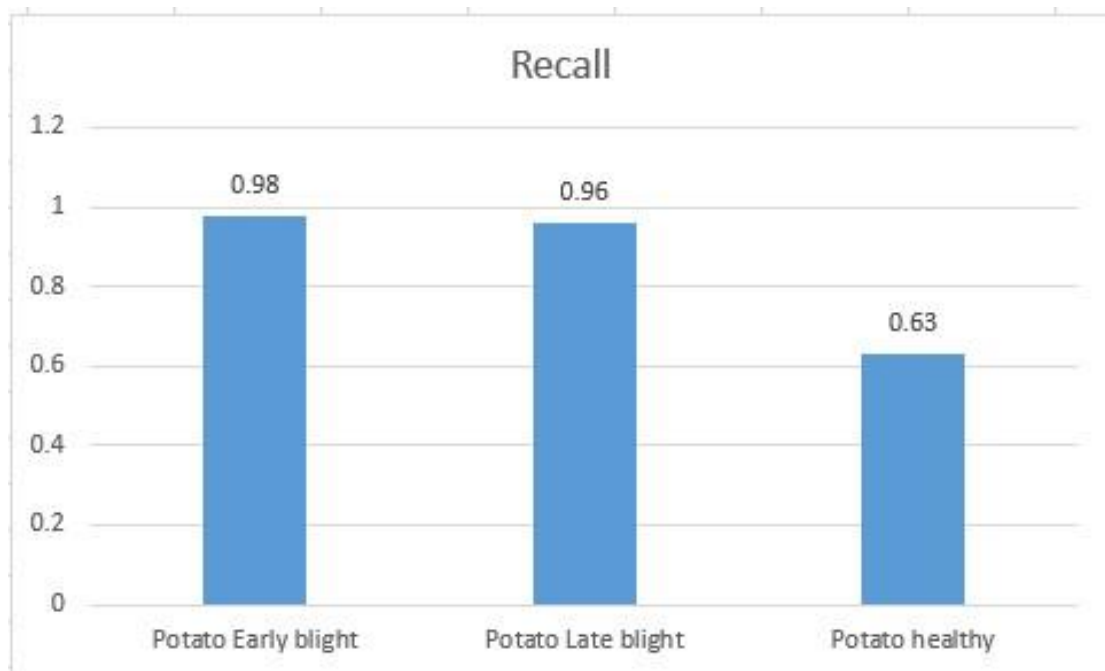


Figure 5.3: Recall for Potato diseases in Bar chart

Here, we have shown in figure 5.2(b) the confusion matrix for Potato Disease.

Prediction												
Actual		Tomato Bacterial spot	Tomato Early blight	Tomato Late blight	Tomato Leaf Mold	Tomato Septoria leaf spot	Tomato Spider mites two spotted spider mite	Tomato Target Spot	Tomato Yellow Leaf Curl Virus	Tomato mosaic virus	Tomato healthy	Total
	Tomato Bacterial spot	163	7	2	3	0	0	1	0	0	0	176
	Tomato Early blight	0	68	0	0	2	0	0	0	3	0	73
	Tomato Late blight	0	0	91	0	0	0	0	5	2	0	98
	Tomato Leaf Mold	0	0	1	30	0	0	0	0	3	0	34
	Tomato Septoria leaf spot	0	0	0	5	44	0	0	0	7	0	56
	Tomato Spider mites two spotted spider mite	0	2	0	4	0	109	0	0	0	4	119
	Tomato Target Spot	0	0	0	0	0	1	85	0	0	5	91
	Tomato Yellow Leaf Curl Virus	0	0	0	16	0	12	0	349	0	0	377
	Tomato mosaic virus	0	0	0	0	0	0	1	0	28	3	32
	Tomato healthy	0	0	0	0	0	2	0	0	5	58	65
	Total	163	77	94	58	46	124	87	354	48	70	1121

Total accuracy of Tomato Disease from the confusion matrix.

Now, we know,

$$\begin{aligned}\text{Accuracy} &= \frac{(\text{TP} + \text{TN})}{\text{Total}} \times 100\% \\ &= \frac{(\text{TP} + \text{TN})}{(\text{TP} + \text{TN} + \text{FP} + \text{FN})} \times 100\%\end{aligned}$$

So, total accuracy

$$\begin{aligned}&= \frac{(163 + 68 + 91 + 30 + 44 + 109 + 85 + 349 + 28 + 58)}{1121} \times 100\% \\ &= 91.44 \%\end{aligned}$$

Table 5.4: Accuracy for individual diseases of Tomato.

Diseases Class	Value
Tomato Bacterial spot	98.84%
Tomato Early blight	98.75%
Tomato Late blight	99.11%
Tomato Leaf Mold	97.15%
Tomato Septoria leaf spot	98.88%
Tomato Spider mites two spotted spider mite	97.77%
Tomato Target Spot	99.29%
Tomato Yellow Leaf Curl Virus	97.06%
Tomato mosaic virus	97.86%
Tomato healthy	98.31%

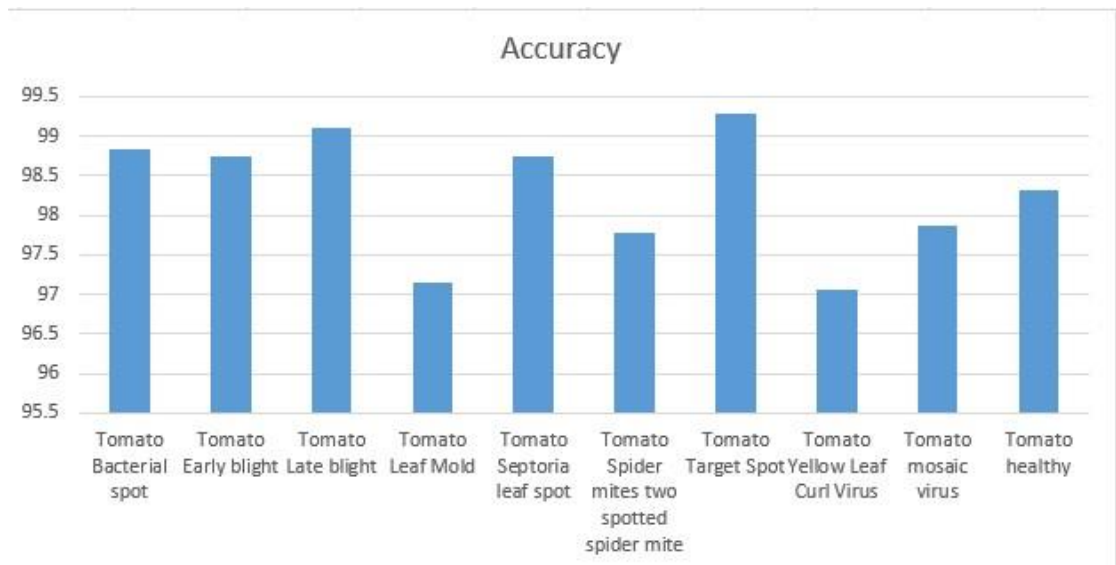


Figure 5.4: Accuracy for Potato diseases in Bar chart

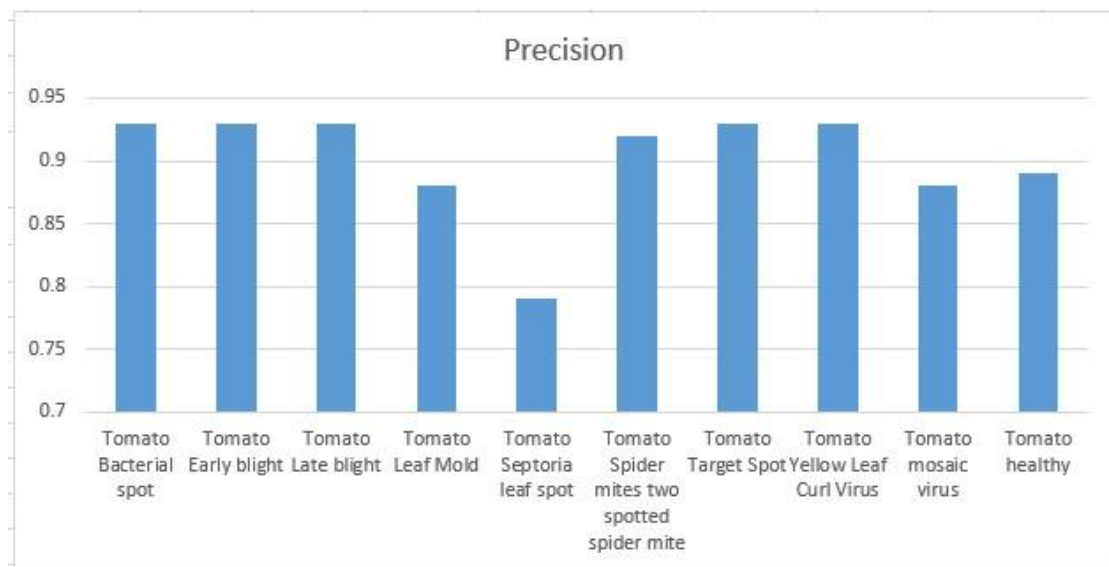


Figure 5.5: Precision for Tomato diseases in Bar chart

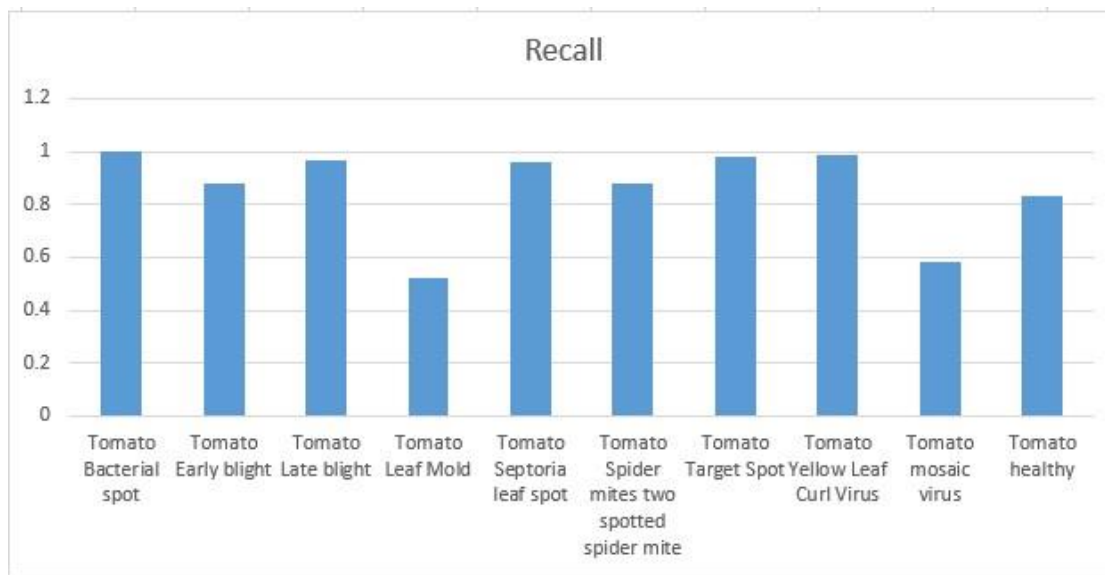


Figure 5.6: Recall for Tomato diseases in Bar chart

5.7. Summary

The chapter is on discussing the execution of this project. This chapter talks about how we have segmented our collected images using Torchvision and other procedures related to our dataset.

CHAPTER 6

CONCLUSION AND FUTURE PLAN

6.1. Conclusion

This project has accomplished to save our valuable time which we had to waste by finding disease manually. This also saves money as well as time by detecting disease quickly and also reduce the damage rate of crops by finding the disease in time and take necessary steps to cure the disease. It will helpful to farmers directly. Besides, other people also benefited indirectly who are involved in agricultural works.

Overall this project may help our country's economy by reducing damage rate and increasing production rate as well.

6.2. Future Plan

In the future, we will create some applications with a proper user interface. such as, Web application, in which users will able to upload an image and the application will able to show the estimated result, whether the image contents any disease or not. And also will provide some solutions and tips related to the disease. We are also hoping to make mobile applications based on our project, i.e. android app or iOS apps. Mainly the mobile app will scan the crop through the mobile camera and check whether there is any disease or not. Besides, it will show the disease details briefly and also will provide some necessary solutions and tips regarding that disease.

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