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INSTITUTE OF INFORMATION TECHNOLOGY
ADDING VALUE TO ENGINEERING
An Autonomous Institute Affiliated to Savitribai Phule Pune University
Approved by AICTE, New Delhi and Recognised by Govt. of Maharashtra
Accredited by NAAC with 'A+' Grade

A

PROJECT REPORT

ON

POMEGRANATE FRUIT DISEASE DETECTION BASED ON MACHINE LEARNING

SUBMITTED IN PARTIAL FULFILMENT OF

THE REQUIREMENTS FOR THE DEGREE

OF

BACHELOR OF ENGINEERING

IN

INFORMATION TECHNOLOGY

UNDER

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

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DEPARTMENT OF INFORMATION TECHNOLOGY

ALL INDIA SHRI SHIVAJI MEMORIAL SOCIETY'S

INSTITUTE OF INFORMATION TECHNOLOGY

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Department of Information Technology

Certificate

This is to certify that the Project Report entitled

POMEGRANATE FRUIT DISEASE DETECTION BASED ON MACHINE LEARNING
Submitted by

YUGAL JAGTAP, VIVEK GAIKWAD, GAURAV SHINDE and VIJAY SHASTRI

is a record of bona-fide work carried out by them, in the partial fulfillment of the requirement for the award of Degree of Bachelor of Engineering in Information Technology at All India Shri Shivaji Memorial Societies' Institute of Information Technology, Pune under the Savitribai Phule Pune University. This work is completed during academic year 2021-22, under our guidance.

Mr.P.B.WAKHARE	Dr. Meenakshi A. Thalor	Dr. P.B.Mane
Project Guide	Head of Department	Principal

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Abstract

This project presents the recent development in automatic vision-based technology. Use of this technology is increasing in agriculture and fruit industry. An automatic fruit quality detection system for sorting and grading of fruits and defected fruit detection discussed here. The main aim of this system is to replace the manual inspection system. This helps in speed up the process improve accuracy and efficiency and reduce time. This system collect image from camera which is placed on conveyor belt. Then image processing is done to get required features of fruits such as color and size. Defected fruit is detected based on image pixels. Sorting is done based on color and size.
Keywords: Image Recognition, CNN, Machine Learning, Neural Network

Chapter 1

INTRODUCTION

1.1 Introduction

India is an agriculture country. Different types of fruits and vegetables are produced in India. India is at second number after China in production fruits. In India all the preharvest and post-harvest process are done manually with help of labor. Manual process is very time consuming, less efficient so to get accurate result automation in agriculture industry is needed. The post- harvest process includes sorting and grading of fruits. Different quality factors are considered for sorting and grading of fruits. These factors are internal quality factors and external quality factors. The external quality factors are texture, shape, color, size and volume, and internal quality factors are test, sweetness, flavor, aroma, nutrients, carbohydrates present in that fruit

1.2 Motivation

Most real-life applications can use fruit recognition and classification systems. An image classifier has been trained and tested to identify images of fruits and vegetables. Nevertheless, the problem of developing a fast and reliable fruit detection system persists. This is due to large variability in fruit appearance in the field, including properties of colour.

1.3 Objectives of the Work

1.To identify various diseases affecting pomegranate.

2.To study different image detection techniques based on machine learning.

3.To design and train the system for disease detection by using machine learning algorithm.

4.To test and validate the system

1.4 Introduction to Convolutional neural networks

Convolutional neural networks are inspired by biological processes in that the pattern of communication between neurons is similar to the arrangement of the visual cortex of animals. Neural network with their amazing ability to retrieve information from complex or indirect data can be used to extract a pattern and detect a more complex tendency that can be seen by other computer techniques. Neural computers use data matching. Neural computers work in a completely different way from normal computer operations. Neural computers are trained (not programmed) to be given a specific initial status (data entry); they separate the input data from one of a number of classes or change the original data in such a way that a particular desirable asset is properly processed.

1.4.1 Layers in a Convolutional Neural Network

A convolution neural network has multiple hidden layers that help in extracting information from an image. The four important layers in CNN are:
1.Convolution layer
2.ReLU layer
3.Pooling layer
4.Fully connected layer

1. Convolution Layer -: It is mathematical function and used to extract feature from input image
In image classification /recognition we not compare 2 images or try to match two images
We extract feature of image and based on that make judgement
It consist of set of learnable filters.
The input image to convolutional layer is an array of pixel values ranging from 0 to 255.
This pixels define the intensity of image(strength and brightness).
Convolution is multiplication in frequency domain.
Here we will move feature/filter to every possible position on image.

Step 1-:Line up feature and image.
Step 2-:Multiply each image pixel by corresponding feature pixel.
Step 3-:add them up. Step 4-:divide by total number of pixels in feature.

we have sliding filter throughput the image and perform filtration again.
*similarly we will perform same convolution with every other filters.

2.ReLU layer-:

All negative values are removed .
Converting all negative values to 0.

3.Pooling Layer-:

It is related to comprehension of feature matrix.
Reduce no of parameters when images are to large.

The most widely used pooling layer has 2*2 scale has 2 approaches :max pooling and average pooling -:

max pooling finds maximum of every patch of the feature map.
Max pooling extracts features like edges and reject big chunk of data
Where as, average pooling extracts features so smoothly , do not reject all data retain a lot of information also not extract good feature hence not widely used.
As the average polling does not extract good feature and hence max pooling is widely used.
Output of this layer is used to train neural network.
You can use this layer many times but as you add layer many times the time require to train the data is much more but as the time require is more the accuracy of model increases .

4. Fully Connected Layer-:

It is used in learn non linear combination if high level features in image.

Chapter 2

LITERATURE SURVEY

In this section, we have discussed briefly some of existing research articles that are related with our work.

2.1 Computer Based Classification of Diseased Fruit using K-Means and Support Vector Machine [1]

In this research work, the proposed image processing techniques are used for diagnosing the diseases in fruits and the other research work has proposed how filtering technique is essential in obtaining accurate resulting finding the region of interest in segmentation part.

2.2 Segmentation Techniques for Rotten Fruit detection [2]

This kind of segmentation technique is based on the pixels of the image. By studying the various pixels, the rotten portion is detected. After identifying the pixels where the rotten portion is there, a marker is added to distinguish that region.

2.3 A Deep Neural Network based disease detection scheme for Citrus fruits [3]

A computer vision-based fruit blemish inspection method will begin with segmentation, followed by extraction of texture characteristics and then lead to the correct gradation of fruits into the corresponding quality categories.

2.4 Jackfruit Fruit Damage Classification using Convolutional Neural Network [4]

The proposed method consists of the image database, then images are preprocessed after that feature are extracted by using k-means clustering. Firstly, some images are used to train the machine learning algorithm and other images are utilized as test images to test the accuracy from the outcome.

2.5 Detection and Classification of Apple Diseases using Convolutional Neural Networks [5]

This paper discusses classifying healthy apples and identifies apple diseases, namely apple blotch, apple scab, and apple rot using Convolutional Neural Network (CNN).

2.6 Early Detection of Pomegranate Disease by using Machine Learning and Internet of Things [6]

The technique identifies the infection at the initial stage by processing the images using MATLAB and provides the required information about the diseases. The cloud database contains the details of leaf, fruit and stem infections and they can be utilized by the farmers at any time using mobile application. And it improves the production and helps the farmers by direct usage.

2.7 Fruit Disease Classification and Identification using Image Processing.[7]

In this paper, we have used different types of diseases of apple fruit namely, Rot, Scab and Blotch in order to verify and validate the given approach.

2.8 Detection and classification of Fruit Diseases using Image Processing and Cloud Computing [8]

Detection and classification of Fruit Diseases using Image Processing and Cloud Computing The technique identifies the infection at the initial stage by processing the images using MATLAB and provides the required information about the diseases. The cloud database contains the details of leaf, fruit and stem infections and they can be utilized by the farmers at any time using mobile application.

2.9 FRUIT FRESHNESS DETECTION USING CNN APPROACH [9]

The main focus is on size, color and existence of defects on citrus fruits. The given experiment is skilled to study the lemons, mandarins and oranges. The study presents a parallel system for estimating size as well as inspecting its surface for diseases. Proposed system is capable of classifying mandarins and lemon correctly with the precision of for tabular representation of literature survey, refer Table 2.1.

Chapter 3

PROPOSED WORK

3.1 Problem Definition

To design and develop a system for pomegranate fruit disease detection based on machine learning.

3.2 Project Scope

Main aim is to enable the system to detect the fruit as affected and further categorize it as type of fruit disease based on the image provided as an input. Also providing the solution based on the disease detected like pesticides and fertilizers to the farmers.

3.3 Project Objectives

1.To identify various diseases affecting pomegranate.

2.To study different image detection techniques based on machine learning. 1

3.To design and train the system for disease detection by using machine learning algorithm.

4.Test and validate the system

3.4 Project Constraints

The constraint associated with the proposed system are as follows:

1. Fruit image needs to be provided as an input.
2. Image processing in real world scenarios needs more filtering.
3. Datasets need to be trained and tested under every possible lighting conditions.

Chapter 4

METHODOLOGY

4.1 System Architecture

In machine learning, a Convolutional neural network (CNN) is a class of deep neural network, most commonly applied to analyze visual imagery. The following diagram gives us idea about basic CNN architecture.

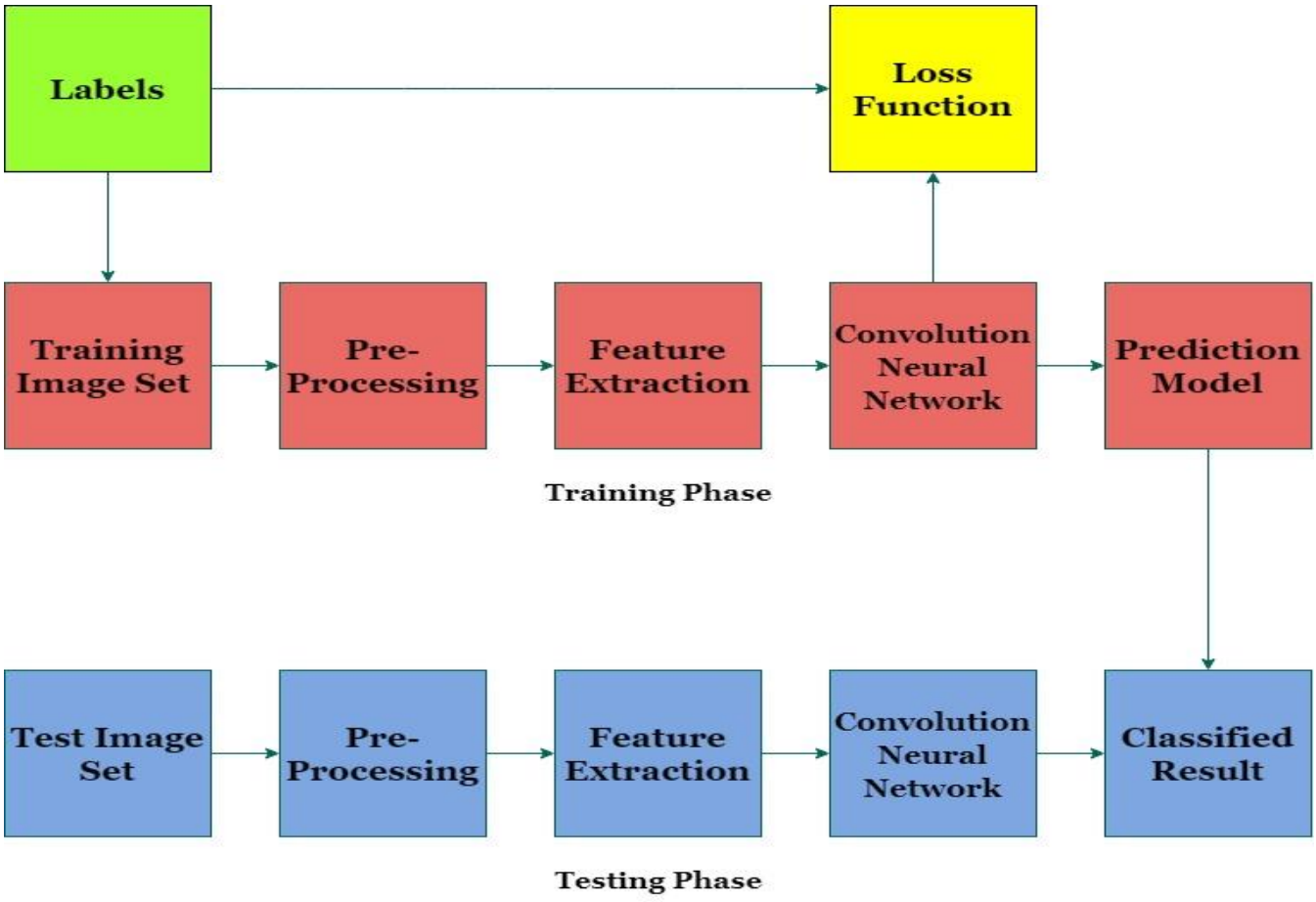


Fig 4.1: System Architecture

4.2 Methodology

In machine learning, a CNN algorithm is a class of deep neural network, most commonly used to analyze images.

4.2.1 Pre-Processing

Preliminary processing of the input image is done by converting the given image to a gray scale. Usually, a standard color image consists of three channels - a red channel, a green channel, a blue channel commonly known as RGB. Then the color image changes to a gray scale with a single monochrome channel to avoid unwanted noise in the image. The input image provided will be of various sizes which can lead to the loss of accurate prediction when the image is compared to that of a trained convolutional neural network. So the image is resized and resized to a blank image of 224 x 224 pixel.

4.2.2 Feature Extraction

Feature releasing is the process of converting input data into a set of features that can best represent input data. Feature removal is related to size reduction. When input data is too large to be processed, it can then be converted into a reduced set of features (also called element vector). Determining the subset of the first elements is called the element selection. Selected features are expected to contain relevant information from the input details, so that the required work can be done using this reduced caption instead of the full initial data. After resizing the image, the pixel values obtained by the same 1D elements represent values between 255 and 0 depending on the pixel density. Refer figure 7.1 for feature extraction and classification structure.

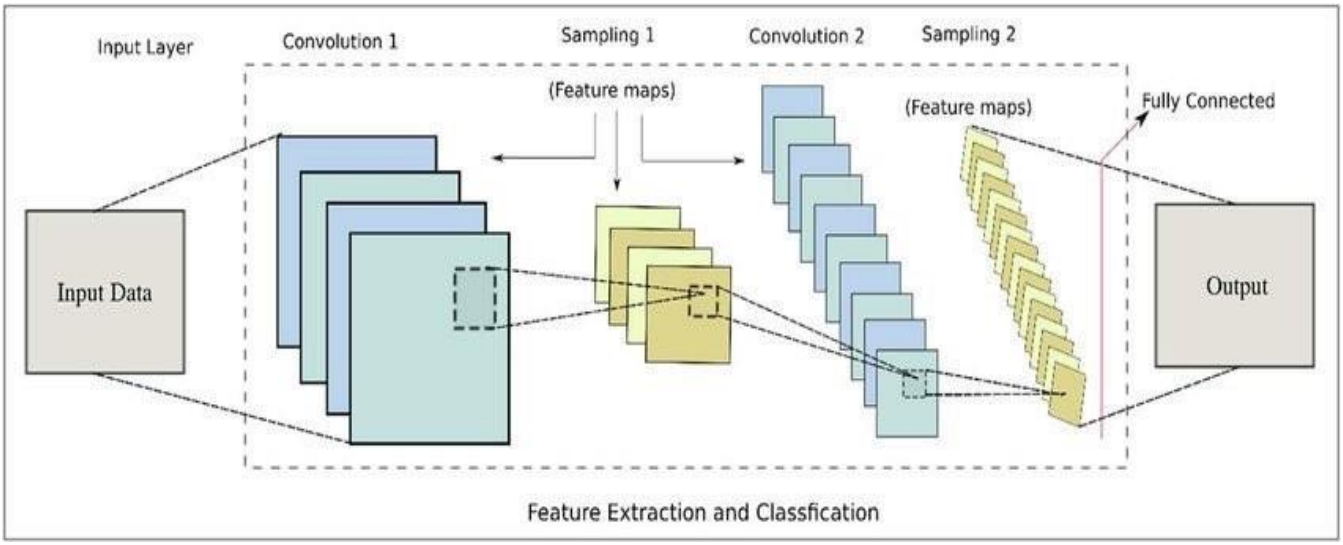


Fig 4.2: Feature Extraction and Classification

4.2.3 The Min-Max Scalar

The standard min-max scalar form uses mean and standard deviations to include all data in the range between a certain min and size. It modifies features by measuring each element in a given range. This rating scale also translates into each individual feature that is at a given level in the training set, e.g. Between zero and 1. This change is often used as an alternative to zero, to measure unit variability. It reduces the width as the width is now between 0 and 1 (or -1 to 1 if there are negative values).

4.2.4 Image Normalization

Normalization is a process that changes the pixel density of the intensity. Normal performance is sometimes called differential stretching or histogram extension. In this image insert normalization is done by removing the background pixels and one character will be provided as it is found in the image. This can be done by using a random value so that the background pixels will have a value less than the pixel values of the character's shadows. In this way the image is usually made to match the image in the Kaggle database.

Fig 4.3: Diseases

4.2.5 Classification

Convolutional neural network is used as a feature extractor from an input image. CNN contains input and output layer, as well as many hidden layers. CNN's hidden layers usually consist of convolutional layers, cohesive layers, fully connected layers and standard layers. CNN consists of three main elements which are the convolutional layer, the compound layer and the extraction layer. The most common activation function used by CNN is ReLU representing the Rectified Linear Unit.

Chapter 5

PROJECT DESIGN

5.1 Hardware Requirements

REQUIREMENTS	SPECIFICATIONS
1. Processor	intel CORE i5 2.7GHz
2. RAM	4 GB
3. HDD	1TB
4. Operating System	Windows 7/10, linux

5.2 Software Requirements

Software	Version
1. Language: Python	3.8.0
2. VsCode	16.4
3. Tensorflow	2.4.0
4. Keras	2.4.3
5. Flask	1.1.2
6. Pillow	8.1.0
7. Opencv	4.5.1

5.3 Risk Analysis

Risk associated with proposed system are:

1. System cannot work in case of power failure.
2. Poor internet connection may take longer time to load website or website loading failure.

ACTIVITY	TITLE	START DATE	END DATE
Activity 01	Group Formation	03/02/2021	03/02/2021
Activity 02	Guide Finalization	19/02/2021	19/02/2021
Activity 03	Topic Finalization	06/03/2021	06/03/2021
Activity 04	Literature Survey	09/03/2021	19/03/2021
Activity 05	Requirements and Technology specifications	08/06/2021	11/06/2021
Activity 06	Base paper submission	08/06/2021	08/06/2021
Activity 07	Designing system Architecture	09/06/2021	09/06/2021
Activity 08	Use case design	11/06/2021	11/06/2021
Activity 09	Designing algorithm	17/06/2021	18/06/2021
Activity 10	Code Implementatior	01/07/2021	22/07/2021
Activity 11	Project Review 1(50% implementation)	03/09/2021	03/09/2021
Activity 12	Working on changes suggested	13/09/2021	18/09/2021

ACTIVITY	TITLE	START DATE	END DATE
Activity 13	Training Dataset	13/09/2021	13/09/2021
Activity 14	Project review 2(70% implementation)	19/12/2021	19/12/2021
Activity 15	Paper published in UGC journal	20/12/2021	20/12/2021
Activity 16	Project phase 1	20/12/2021	20/12/2021

5.4 Project Schedules

In this chapter we are going to have an overview about how much time does it took to complete each task like- Preliminary Survey Introduction and Problem Statement, Literature Survey, Project Statement, Software Requirement and Specification, System Design, Partial Report Submission, Architecture Design, Implementation, Deployment. Testing, Paper Publish, Report Submission and etcetera. This chapter also gives focus on stakeholder list which gives information about project type, customer of the proposed system, user and projectmember who developed the system.

System Implementation Plan:

The System Implementation plan table 2, shows the overall schedule of tasks compilation and time duration required for each task.

Table 2: Project Schedule

Sr. No.	POMEGRANATE FRUIT DISEASE DETECTION BASED ON MACHINE LEARNING	Start Date	End Date
1	Preliminary Survey	8/6/2021	15-06-2021
2	Introduction and Problem Statement	16-06-2021	29-06-2021
3	Literature Survey	30-06-2021	6/7/2021
4	Project Statement	7/7/2021	9/7/2021
5	Software Requirement and Specification	10/7/2021	20-07-2021
6	System Design	21-07-2021	28-07-2021
7	Partial Report Submission	29-07-2021	20-08-2021
8	**Project Review I**	**3/9/2021**	**3/9/2021**
9	Implementation	4/9/2021	19-03-2022
10	**Project Review II**	**8/10/2021**	**8/10/2021**
11	Testing	10/10/2022	29-01-2022
12	**Project Review III**	**2/2/2022**	**2/2/2022**
13	Paper Publish	21-04-2022	21-04-2022

14	**Project Review IV**	**29-04-2022**	**29-04-2022**
15	Report Submission	13-05-2022	13-05-2022

5.5 UML Design and Documentation

The use case diagram given below 5.5 gives a brief visual information about the system which detects diseases of pomegranate.

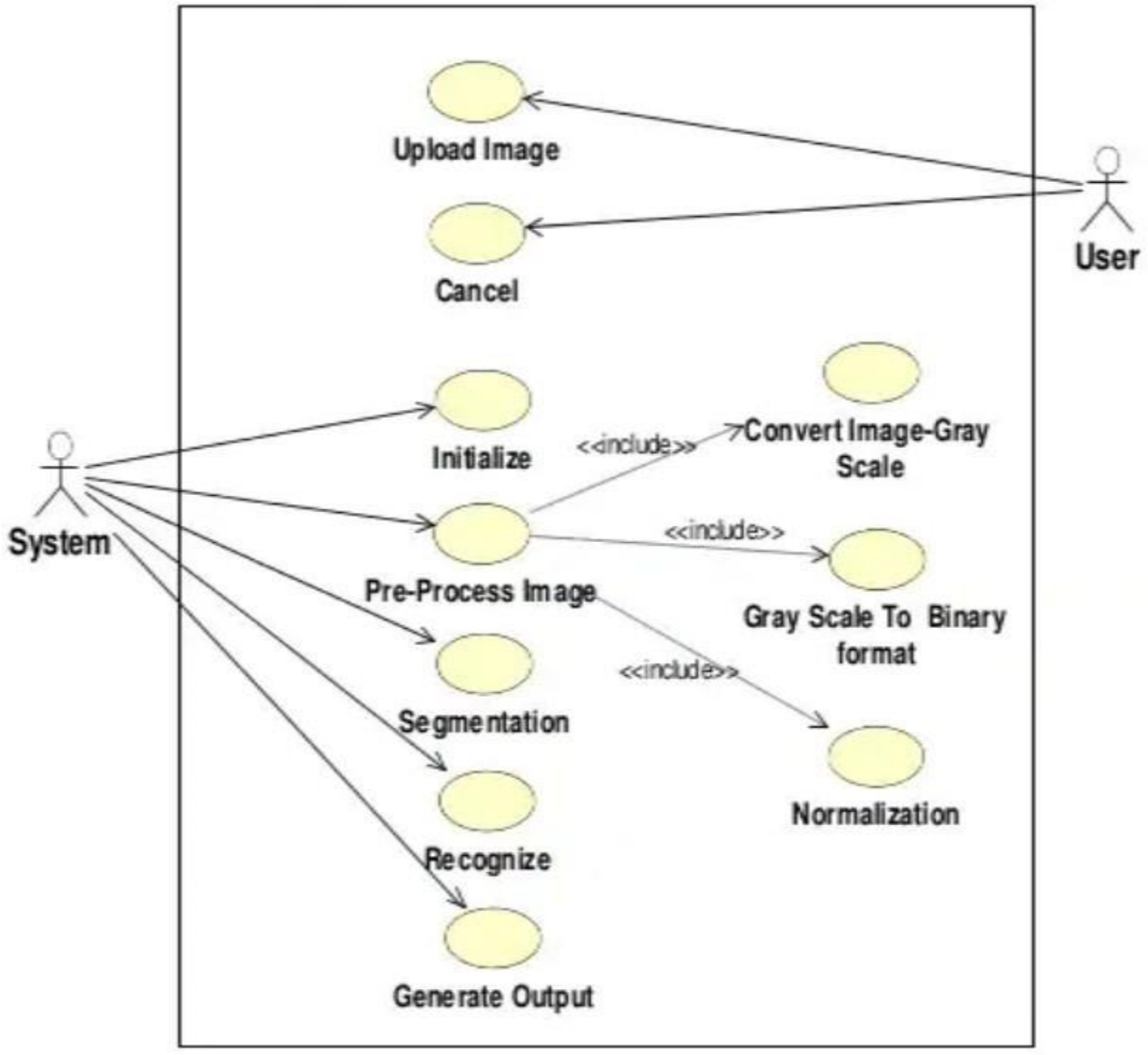


Fig 5.5: UML Diagram

Chapter 6

SYSTEM IMPLEMENTATIONS

6.1 Important Libraries /Packages NumPy: -

NumPy stands for Numerical Python. NumPy is a library containing of multidimensional array objects and a group of routines.

For processing those arrays. Logical mathematical and operations on arrays can be accomplished Using NumPy.

In 2005, Travis Oliphant created NumPy package by integrating the features of Numarray into Numeric package.

There are many contributors to this open-source project. Using NumPy, a developer can perform the following operations −
1.Mathematical and logical operations on arrays.
2. routines and Fourier transforms for shape manipulation.
3.Operations related to linear algebra. NumPy has in-built functions for random number generation and linear algebra.

TensorFlow: -

TensorFlow is an open-source platform for machine learning. It has a comprehensive, flexible ecosystem of tools, libraries, and community resources that lets researchers push the state-of-the-art in ML, and gives developers the ability to build and deploy ML-powered applications easily

TensorFlow provides a collection of workflows, high-level APIs for both beginners and experts to create machine learning models in many languages. Developers have the option to deploy models on a number of platforms such as on servers, in the cloud, in browsers. JavaScript platforms.

OpenCV (Open-Source Computer Vision Library) is an open-source software library for computer vision and machine learning.

OpenCV was created to provide a shared infrastructure for applications for computer vision and to speed up the use of machine perception in consumer products. There are some predefined packages and libraries that make our life modest and OpenCV is one of them.

6.2 Implementing Algorithms

Convolution Neural Networks are neural networks that share their parameters. Visualize you have an image. It can be characterized as a cuboid having its length, width and height.

CNNs are used for image classification and recognition because of its high accuracy., when he was inspired from the human visual perception of recognizing things.

Compared to its predecessors, the main advantage of CNN is that it automatically detects the important features without any human supervision. This is why CNN would be an ideal solution to computer vision and image classification problems.

6.3 Steps for Implementing Module

Step 1: Run mySite.py File.

Step 2: After running mySite.py type localhost:5000/ to any browser of your choice.

Step 3: After Entering following local address, website homepage will open. Then click on Detect Pomegranate Disease tab on the left side of the homepage.

Step 4: Click on choose file and select any pomegranate sample from your local device storage.

Step 5: After selecting the desired pomegranate sample click on upload button.

Step 6: After uploading the following image, click on Test button to check if it is affected by any of the following diseases like Bitter Rot, Butterfly Pomegranate, Bacterial Blight or it is Normal.

6.3 Graphics User Interface Screenshots

Following Figure Fig 6.1 shows code to be executed for disease detection system.

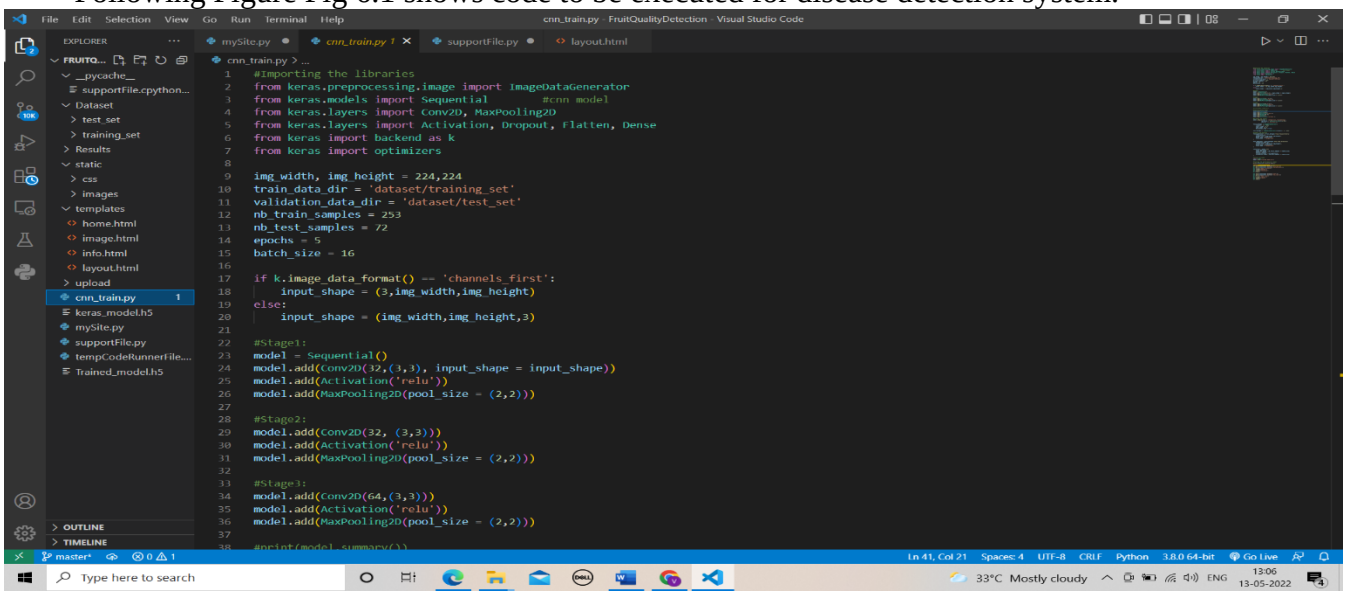
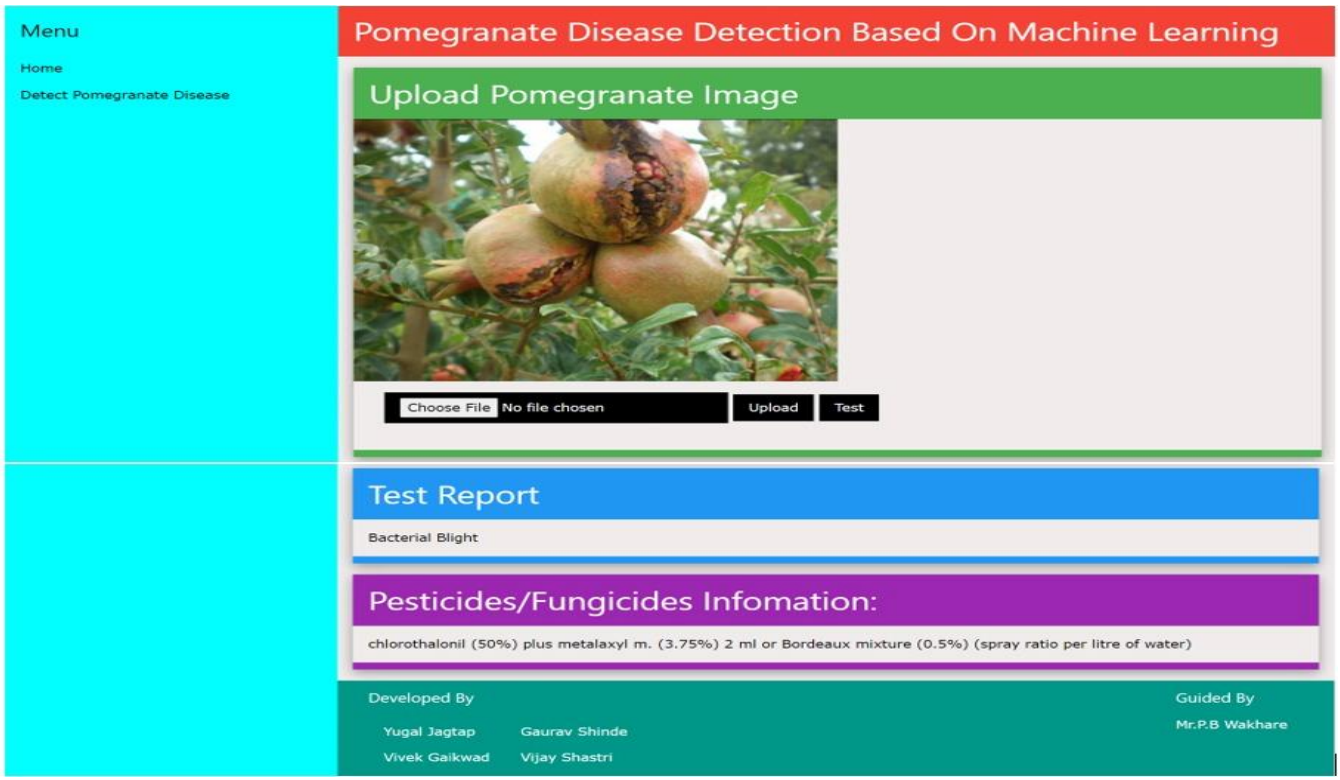


Fig 6.1: Code part of Fruit disease detection

Following Figure Fig 6.2 UI for disease detection system.



Following Figure Fig 6.3 User interface showing disease on testing.

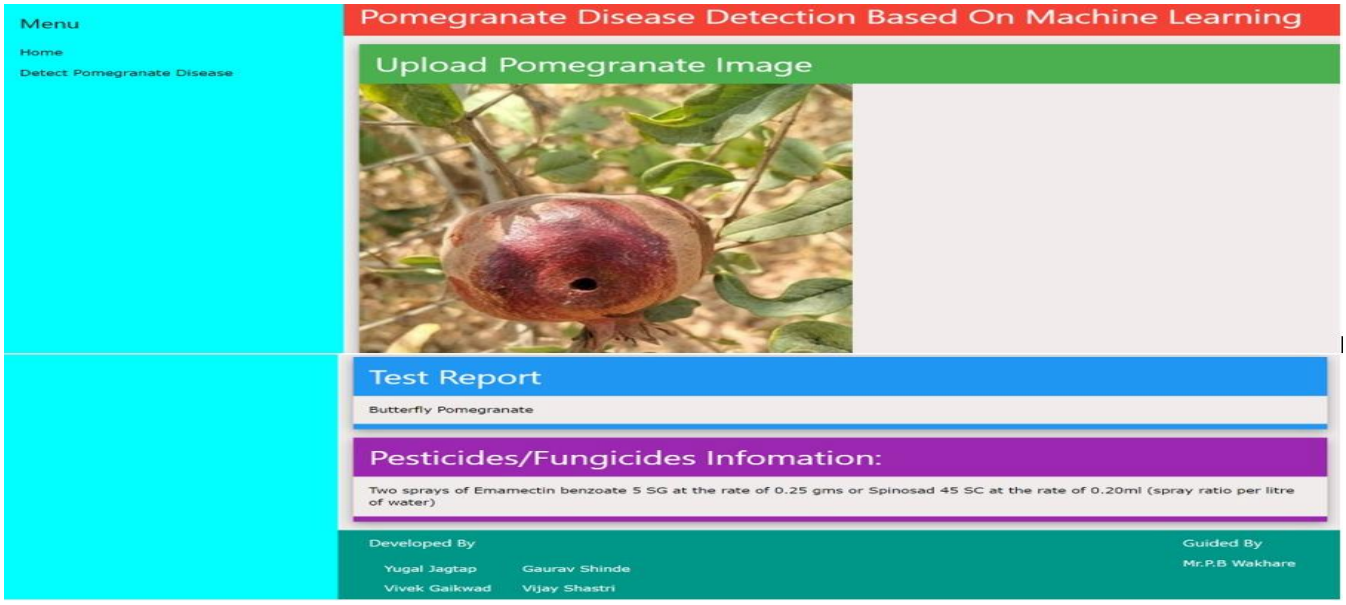


Fig 6.3: Butterfly Pomegranate disease

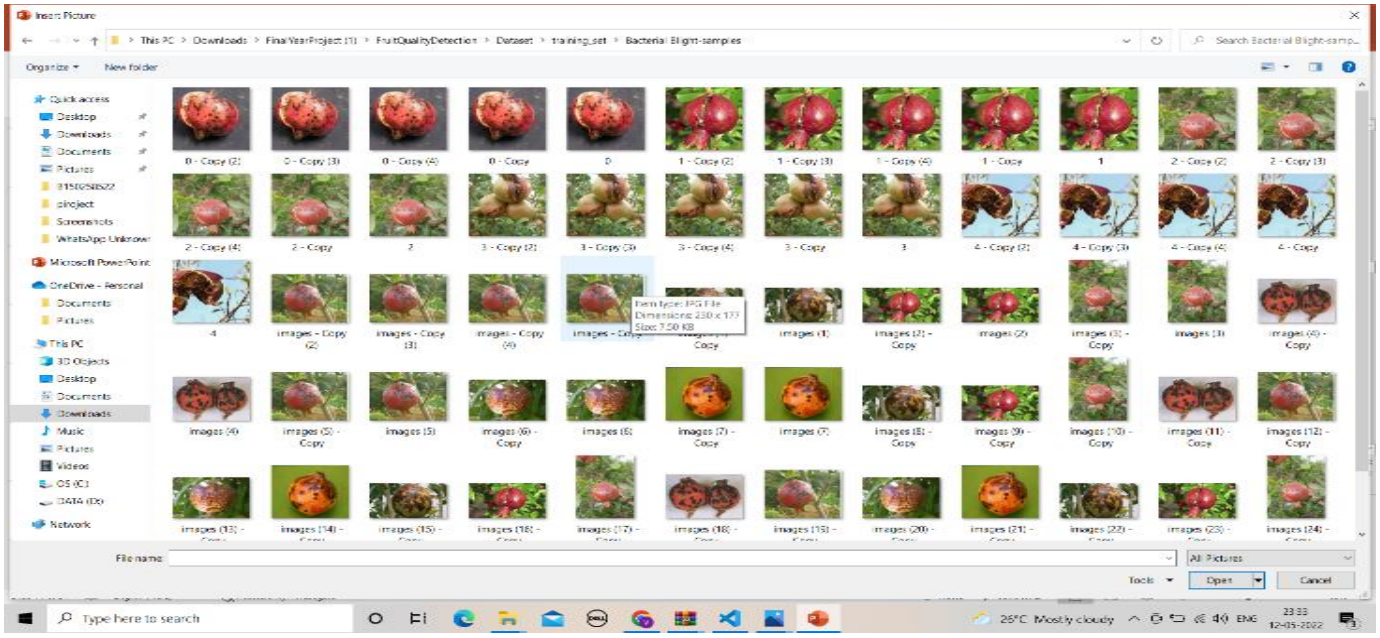


Fig 6.4 Training_Database Baccterial_Blight

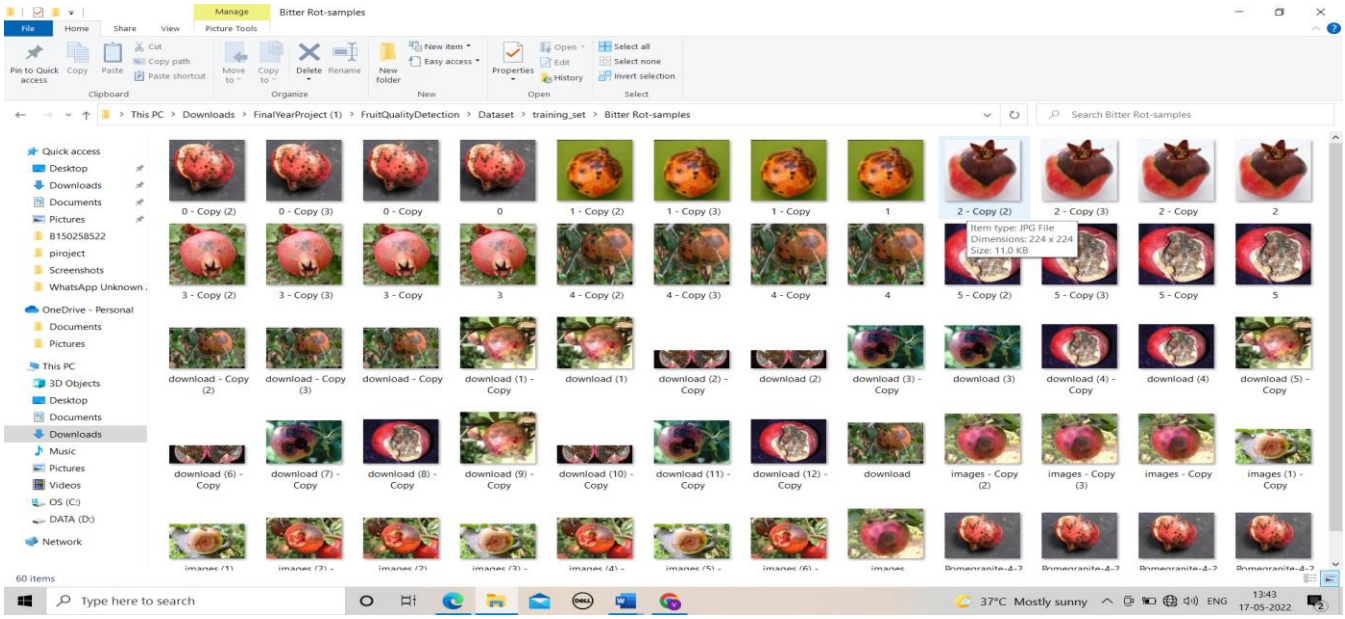


Figure 6.5-:Training set Bitter Rot sample

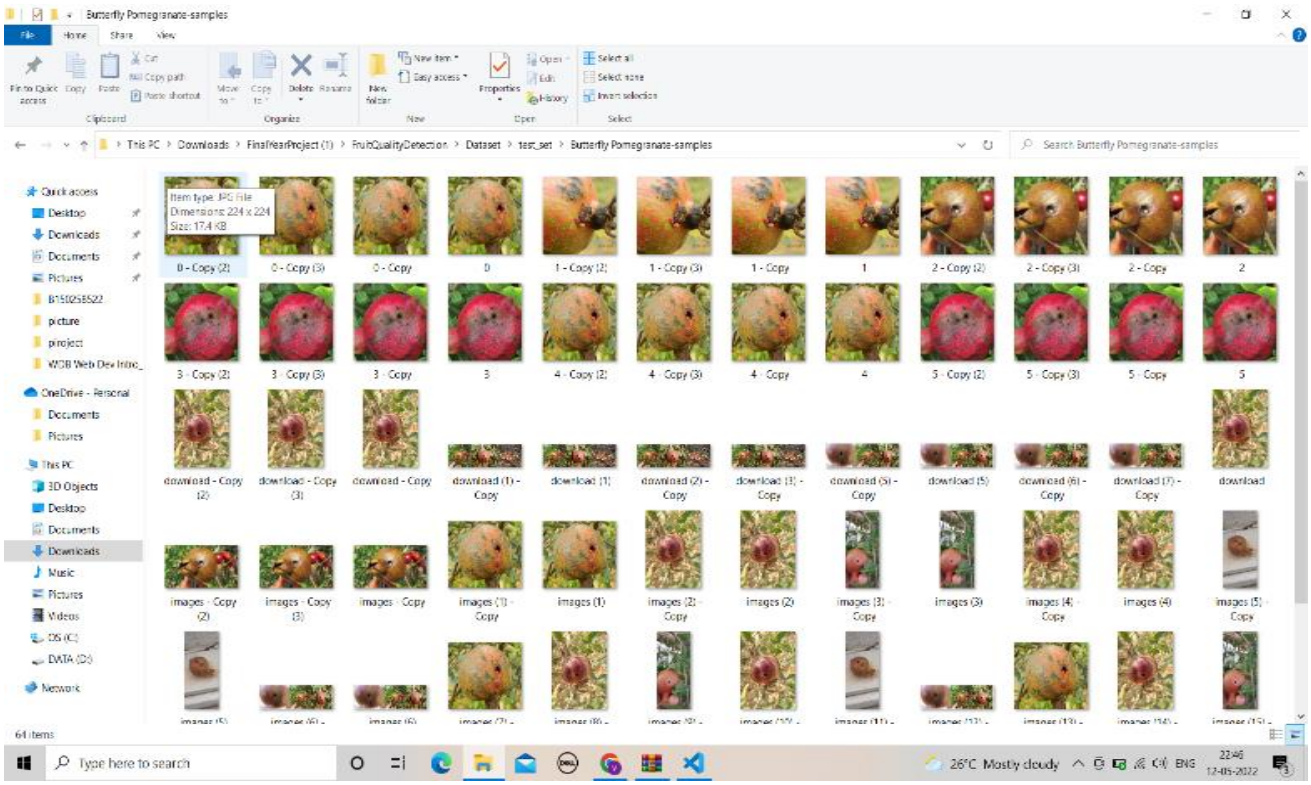


Fig 6.6: Testing Database Butterfly Pomogrenate

Z

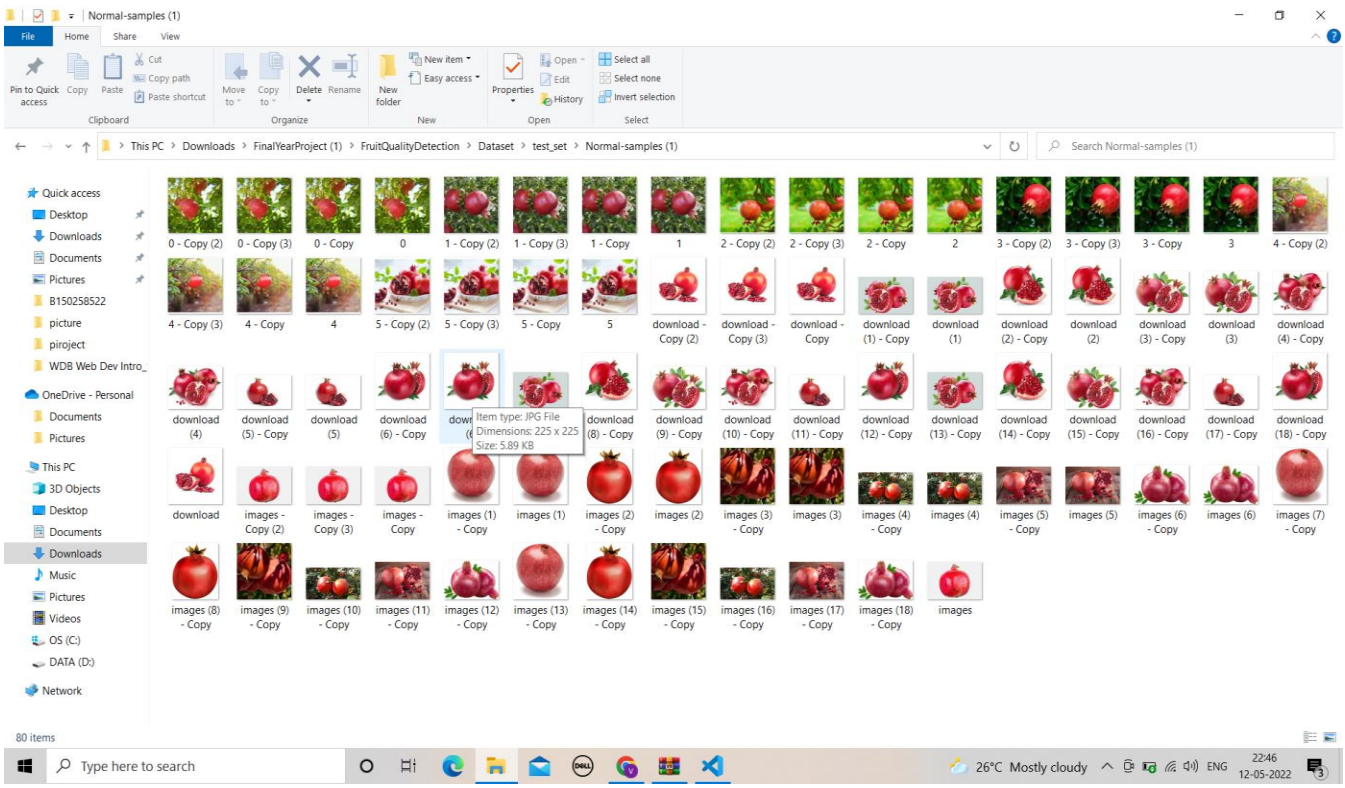


Figure 6.7-Test_set Normal Sample

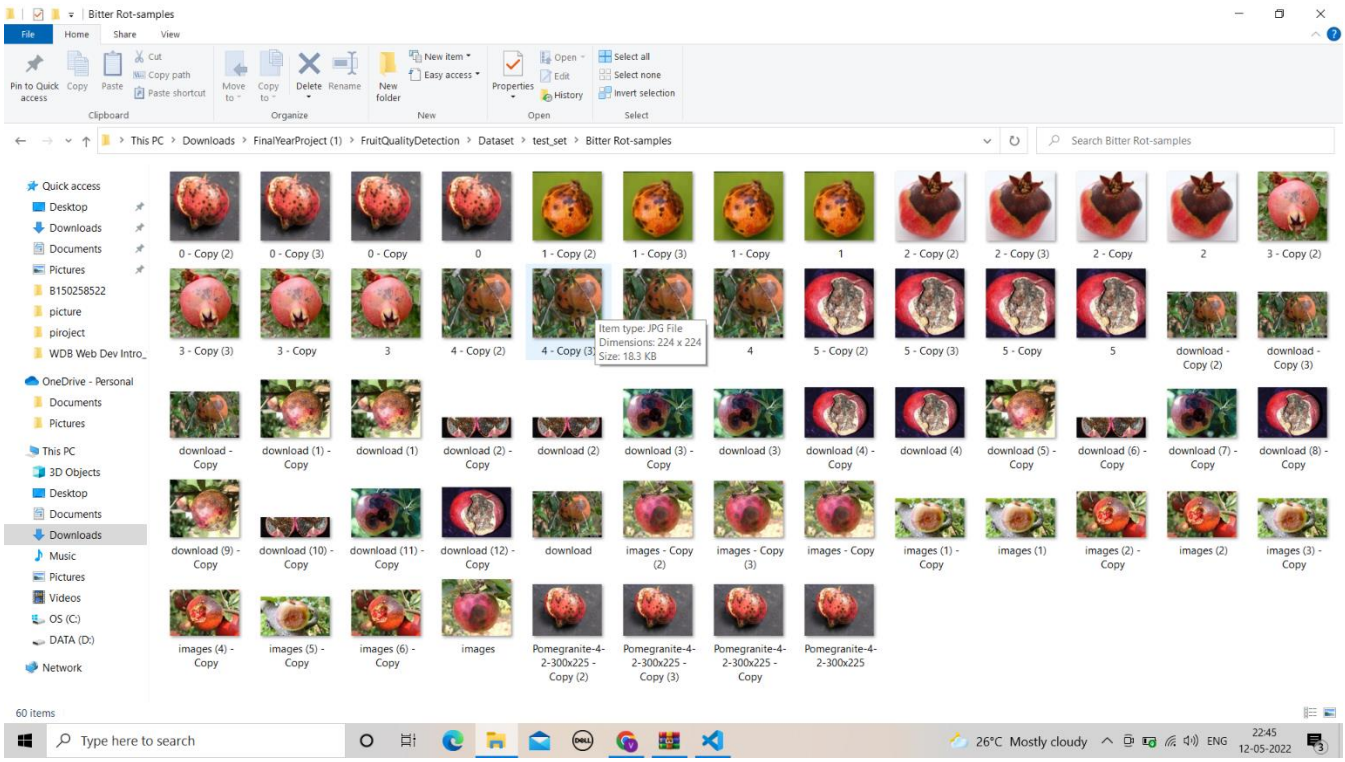


Figure 6.8-Test_set Bitter-rot Sample

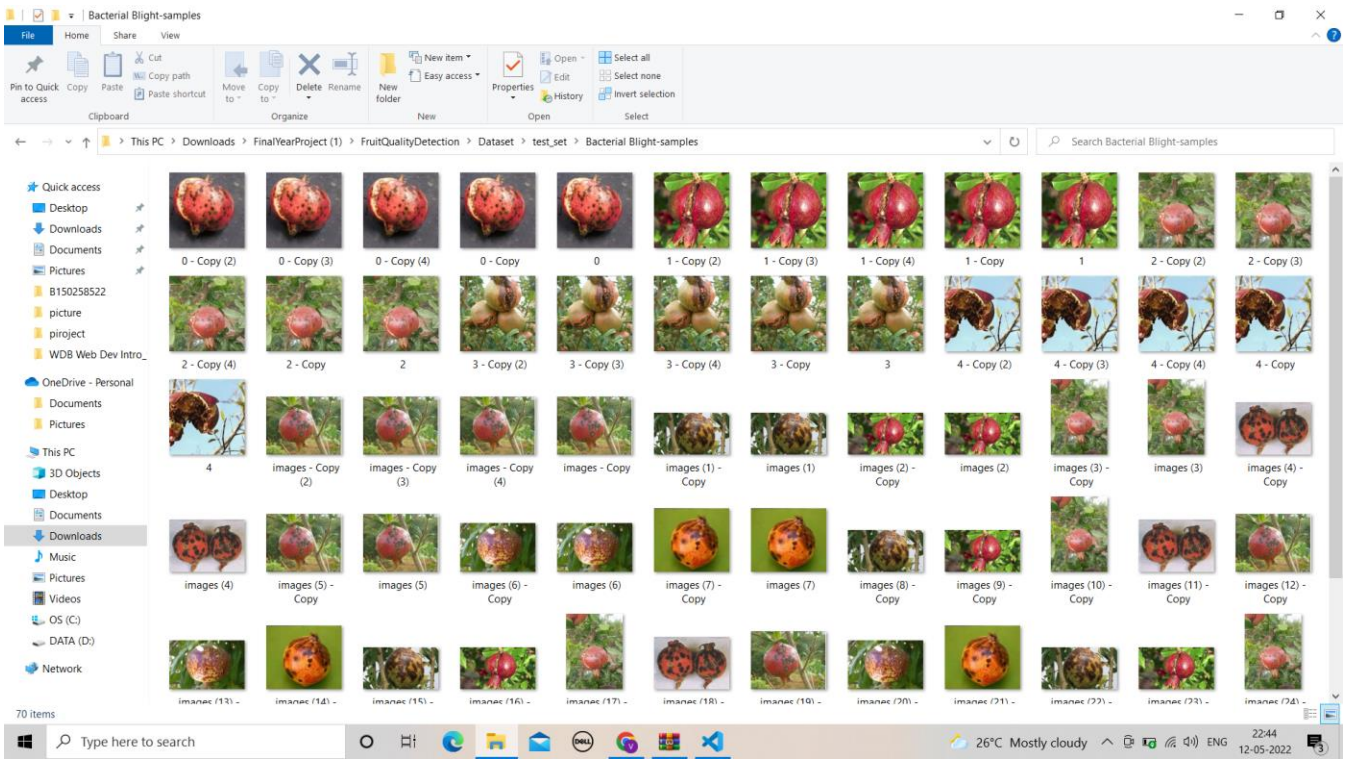


Figure 6.9-Test_set Bacterial Blight Sample

Chapter 7

SYSTEM TESTING

7.1 Introduction of Testing:

Testing is very important phase of the software development life cycle. The purpose of this phase is to check the lifetime of the system. This is mandatory phase. Information given in this chapter gives the details for the testing activities that should be approved. Tester has to estimate test of each component and write downs test cases according to user requirement and system structure.

7.1.1 Principle of Testing:

- To know the performance of the system.
- To recognize the functionality of each and every module.
- To verify whether system is functioning as per the user requirements

7.2 Testing scope:

Testing is important in software engineering to validate and verify project. Main aim of the testing is to verify the system by detecting bugs or defect in the different modules. Due to testing phase, system is analyzed for probable risks in project.

7.2.1 Major Functionalities:

Following are some main functionalities of this project:

- Disease Detection.
- Provide solution for Disease.

7.3 Basics of Software Testing:

7.3.1 White-box testing:

The White box testing is done by the tester who has knowledge of the programming language. White box testing is carried out on algorithm or source code of the project. It is the process or action of giving the input to the project and verifying that how system process input to produce result. In white box testing all, the details are required to known to tester i.e., the interior details. White box testing is also known as transparent testing.

This test needs source code to check so it is essential for tester to have the knowledge of coding.

Following are the techniques of White Box testing:

- Programming style
- Control method
- Source language

This type of a test is useful to beat defects at structural level. This test goes from lower the top or functional layer to expose bugs or defects.

Test case designing methods:

- Statement coverage
- Decision coverage
- Condition coverage
- Multiple Condition coverage
- Path coverage

7.3.2 Black box Testing:

This type of testing takes place by actual validating of user requirement with obtained or actual result. In the black box testing tester does not require knowing the source or internal logic of the project. He concerns with the actual result generated by the system. Functional testing is carried out in black box testing. Here, the knowledge about how the program internally executes or the programming language does not require

7.3.3 Unit testing:

Unit testing is small module of a system to check it might be as methods, functions, classes of code, interface and of system. Therefore here, tester will test each and every small unit of the system to investigate whether the module is suitable for the system. Software writes allumettes and carried out to verify that code complete necessities, design and perform as per user requirement. Unit testing has few advantages like those that error and bugs found at early stage. Because of the issues found at very early stage and determined instantly is not disturbing the other part of codes.

7.3.4 Integration testing:

In the Integration testing, different modules have combined together and tested. To exchange information easily between distinct modules of the system, test that its performance as per the given requirement. When all testing related work is completed, the software is deployed/delivered to the customer. Stress and load testing is carried out in the integration testing

7.3.5 Validation testing:

In this testing, tester will verify the software that it covers all the requirements as per the system requirement specification. It makes sure that the requirement of software was at correct place. It also verifies whether we have built right system or not.

It checks the following:

- It justifies the execution and behavior of the system.
- All probable input data given as input and capture projected output.
- Test log is used for deployment

7.3.6 System Testing:

After performing the integration testing the further step is output testing of the proposed system. system could not be useful if it does not produce the required output in a specified format. The outputs generated are displayed by the user.

7.4 Test Strategy:

7.4.1 Testing Process:

There are extraordinary procedures for trying out the software. The diverse steps been described underneath:

- A demand of device is to be examined.
- The expected time of results after each testing module is been diagnosed.
- Testing which is been associated with equipment's and reference record that are required to execute have to be listed.
- Deploy the setup for testing for check surroundings.

7.4.2 Functionality Testing And Non-Functional Testing:

7.4.2.1 Functionality Testing:

Capability checking out is accomplished to test the functionality of software program as in keeping with layout specification of that software and is it operating as per requirement or no longer. In functionality testing center capability of the utility tested with the aid of tester. Middle level functionalities like input given, methods and setup on machine. It promotes test and affirm a specific approach or characteristic of the program. Useful trying out may be very clean i.e. consumer can do it easily.

7.4.2.2 Project Aspect:

In the proposed system, all the function was tested by tester as well as developer. The system has major functionality like Fruit disease detection. These are mainfunctionality of the system are implemented successfully and working as per the expectation

7.4.2.3 Non-Functional Testing:

Non-useful trying out is been related to the best and functions of the module of software program. No useful not concerning to a specific feature or person movement along with load control but it related to software program features. Non-practical testing may be Reliability checking out, Usability trying out etc.

7.5 Test Cases and Results:

After implementation section while tester assessments code it detects the a few faults or disorder inside the code. The faults corrected through a few methods in short time. While testing the performed by means of creating the test instances. There are different pomegranate fruit test cases performed for 3 types of different diseases and it tested with the anticipated output by way of system or software.

Chapter 8

EXPERIMENTAL RESULTS

After successful epochs , the system generates a graph for Model accuracy and model loss.
For model accuracy, the line graph shows how system accuracy is achieved at every epoch in test dataset over training dataset.
For model loss, system depicts reduced error and detection of fruit diseases at every epoch.

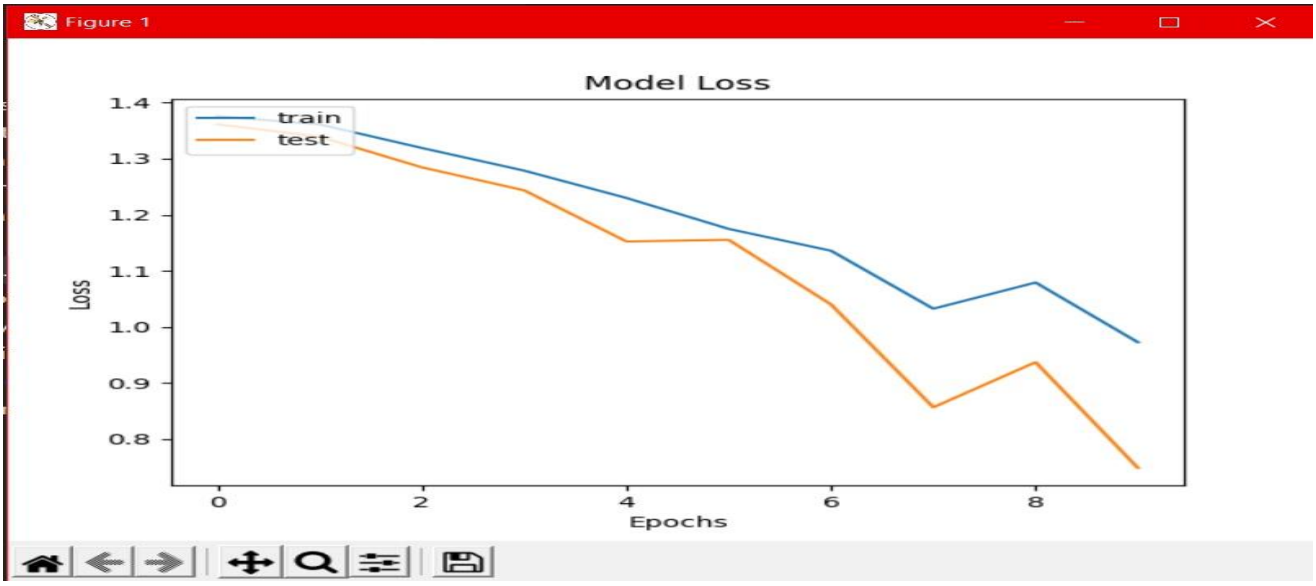


Figure 8.1 Model Loss

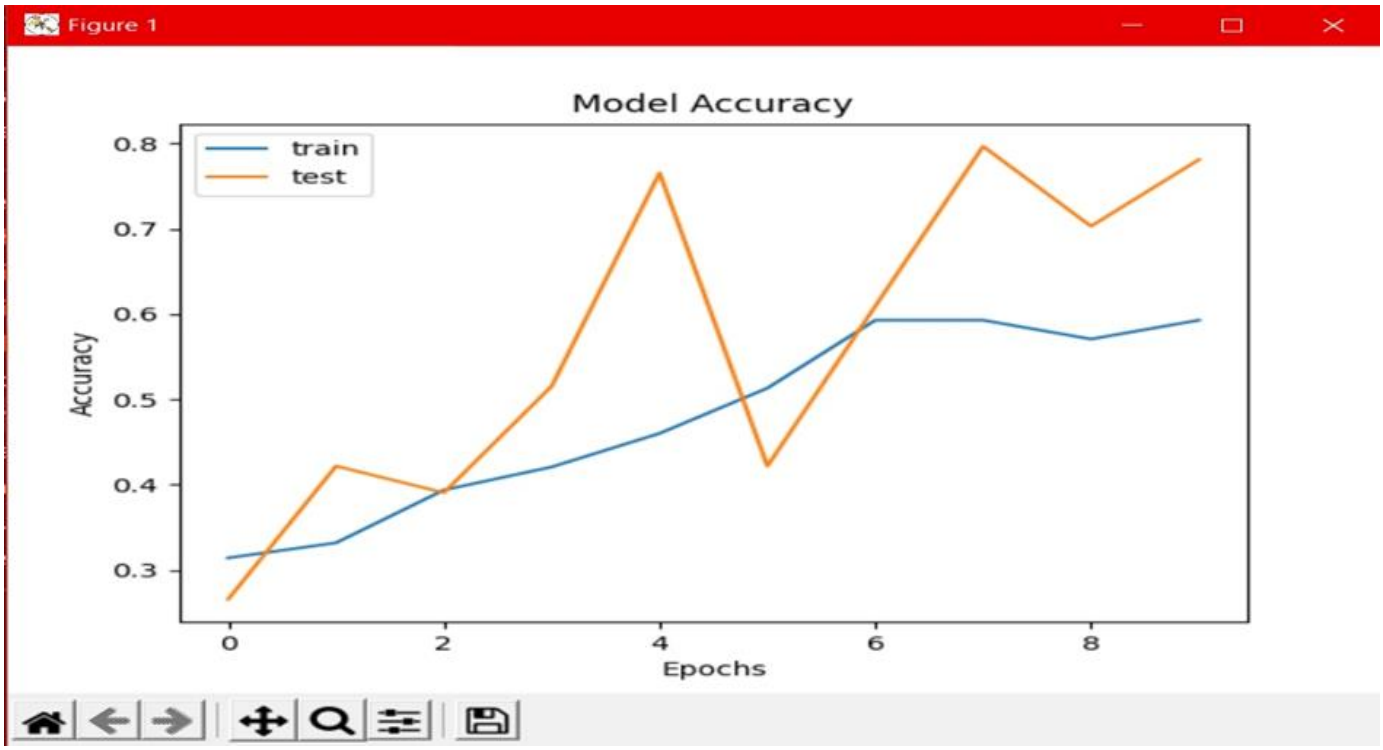


Figure 8.2 Model Accuracy

Chapter 9

CONCLUSION

The system takes an input image of a Pomegranate, processes it using Convolutional Neural Network algorithm by image augmentation , RGB color gradient and feature extraction from image successfully categorizes it under different diseases like bacterial blight, butterfly pomegranate, bitter rot.
It also provides preventive measures to the farmers in the form of various pesticides and fertilizers to be used on the crop for better harvesting and to avoid loss of fruits.
After increasing successfully epochs , the system shows high model accuracy chart for better understanding of the improvised algorithm for both training and testing datasets.
By increasing the number of training datasets images we can increases training model accuracy and try to provide best results for farmers.

Chapter 10

FUTURE SCOPE

We plan to make it a IOT based system and test it under real world conditions using cameras for live footage capturing. Further, to enable the system to be effective for other fruits and crops and provide a better harvest to the farmers by reducing manual labor.

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Pomegranate Fruit Disease Detection Based on Machine Learning

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Abstract: *This project presents the recent development in automatic vision-based technology. Use of this technology is increasing in agriculture and fruit industry. An automatic fruit quality detection system for sorting and grading of fruits and defected fruit detection discussed here. The main aim of this system is to replace the manual inspection system. This helps in speed up the process improve accuracy and efficiency and reduce time. This system collect image from camera which is placed on conveyor belt. Then image processing is done to get required features of fruits such as color and size. Defected fruit is detected based on image pixels. Sorting is done based on color and size.*

Keywords: Image Recognition, CNN, Machine Learning, Neural Network

I. INTRODUCTION

India is an agriculture country. Different types of fruits and vegetables are produced in India. India is at second number after China in production fruits. In India all the preharvest and post-harvest process are done manually with help of labor. Manual process is very time consuming, less efficient so to get accurate result automation in agriculture industry is needed. The post- harvest process includes sorting and grading of fruits. Different quality factors are considered for sorting and grading of fruits. These factors are internal quality factors and external quality factors. The external quality factors are texture, shape, color, size and volume, and internal quality factors are test, sweetness, flavor, aroma, nutrients, carbohydrates present in that fruit

Most real-life applications can use fruit recognition and classification systems. An image classifier has been trained and tested to identify images of fruits and vegetables. Nevertheless, the problem of developing a fast and reliable fruit detection system persists. This is due to large variability in fruit appearance in the field, including properties of colour

II. METHODOLOGY

1. Pre-Processing

Preliminary processing of the input image is done by converting the given image to a gray scale. Usually, a standard color image consists of three channels - a red channel, a green channel, a blue channel commonly known as RGB. Then the color image changes to a gray scale with a single monochrome channel to avoid unwanted noise in the image. The input image provided will be of various sizes which can lead to the loss of accurate prediction when the image is compared to that of a trained convolutional neural network. So the image is resized and resized to a blank image of 224 x 224 pixel.

2. Feature Extraction

Feature releasing is the process of converting input data into a set of features that can best represent input data. Feature removal is related to size reduction. When input data is too large to be processed, it can then be converted into a reduced set of features (also called element vector). Determining the subset of the first elements is called the element selection. Selected features are expected to contain relevant information from the input details, so that the required work can be done using this reduced caption instead of the full initial data. After resizing the image, the pixel values obtained by the same 1D elements represent values between 255 and 0 depending on the pixel density.

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3. The Min-Max Scalar

The standard min-max scalar form uses mean and standard deviations to include all data in the range between a certain min and size. It modifies features by measuring each element in a given range. This rating scale also translates into each individual feature that is at a given level in the training set, e.g. Between zero and 1. This change is often used as an alternative to zero, to measure unit variability. It reduces the width as the width is now between 0 and 1 (or -1 to 1 if there are negative values).

4. Image Normalization

Normalization is a process that changes the pixel density of the intensity. Normal performance is sometimes called differential stretching or histogram extension. In this image insert normalization is done by removing the background pixels and one character will be provided as it is found in the image. This can be done by using a random value so that the background pixels will have a value less than the pixel values of the character's shadows. In this way the image is usually made to match the image in the Kaggle database

5. Classification

Convolutional neural network is used as a feature extractor from an input image. CNN contains input and output layer, as well as many hidden layers. CNN's hidden layers usually consist of convolutional layers, cohesive layers, fully connected layers and standard layers. CNN consists of three main elements which are the convolutional layer, the compound layer and the extraction layer. The most common activation function used by CNN is ReLU representing the Rectified Linear Unit

III. CONCLUSION

The system takes an input image of a Pomegranate, processes it using Convolutional Neural Network algorithm by image augmentation , RGB color gradient and feature extraction from image successfully categorizes it under different diseases like bacterial blight, butterfly pomegranate, bitter rot. It also provides preventive measures to the farmers in the form of various pesticides and fertilizers to be used on the crop for better harvesting and to avoid loss of fruits. After increasing successfully epochs, the system shows high model accuracy chart for better understanding of the improvised algorithm for both training and testing datasets. By increasing the number of training datasets images we can increases training model accuracy and try to provide best results for farmers.

IV. FUTURE SCOPE

We plan to make it a IOT based system and test it under real world conditions using cameras for live footage capturing. Further, to enable the system to be effective for other fruits and crops and provide a better harvest to the farmers by reducing manual labor.

V. ACKNOWLEDGEMENT

There is always a sense of gratitude that people express towards others for their help and supervision in achieving the goals. This formal piece of acknowledgment is an attempt to express the feeling of gratitude towards people who helped me in completing my presentation. I would like to express my deep and sincere gratitude to my seminar guide, Mr. P.B. Wakhare for allowing me to do this work and providing invaluable guidance. I would like to express my deep gratitude to Dr. P. B. Mane, Principal, Dr. Meenakshi A. Thalor, Head of Department, and Dr. J. B. Patil, Project Coordinator for their constant cooperation. They were always there with competent guidance and valuable suggestions throughout the pursuance of this presentation. I would like to convey my sincere gratitude to Algorithmic Electronics Pvt. Ltd. for sponsoring my project and also for providing all the necessary information. I would also like to appreciate all the respondents and group members whose responses and coordination were of utmost importance for the presentation and who helped me a lot in collecting necessary information. Above all, no words can express my feelings to my parents, friends, and all those people who supported me during my seminar. Vivek Gaikwad, Gaurav Shinde, Yugal Jagtap, Vijay Shastri AISSMS IOIT, Pune

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PROJECT BASED REPORT ON POMEGRANATE FRUIT DISEASE DETECTION BASED ON MACHINE LEARNING BY Vivek Gaikwad, Gaurav Shinde, Yugal Jagtap, Vijay Shastri PRN No: 71907960J, 71907964M, 72001594E, 72001601M Under the guidance of Mr. P.B. Wakhare DEPARTMENT OF INFORMATION TECHNOLOGY ALL INDIA SHRI SHIVAJI MEMORIAL SOCIETY'S INSTITUTE OF INFORMATION TECHNOLOGY PUNE 411001 SAVITRIBAI PHULE PUNE UNIVERSITY 2021-22

DEPARTMENT OF INFORMATION TECHNOLOGY CERTIFICATE This is to certify that Vivek Gaikwad PRN No.:71907960J, Gaurav Shinde PRN No.:71907964M, Yugal Jagtap PRN No.:72001594E, Vijay Shastri PRN no.:72001601M from Fourth Year Information Technology has successfully completed his project report work titled POMEGRANATE FRUIT DISEASE DETECTION BASED ON MACHINE LEARNING at All India Shri Shivaji Memorial Society's Institute of Information Technology, Pune in the partial fulfillment of the Bachelors Degree in Information Technology Mr. P.B. Wakhare Dr. Jaydeep B. Patil Internal Guide Project Coordinator Seal/Stamp of the college Dr. Meenakshi A.Thalor Head of Department Place: PUNE Information Technology Date:

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Vivek Gaikwad, Gaurav Shinde, Yugal Jag- tap, Vijay Shastri AISSMS IOIT, Pune. i

Abstract This project presents the recent development in automatic vision based technology. Use of this technology is increasing in agriculture and fruit industry. An automatic fruit quality detection system for sorting and grading of fruits and defected fruit detection discussed here. The main aim of this system is to replace the manual in- spection system. This helps in speed up the process improve accuracy and efficiency and reduce time. This system collect image from camera which is placed on conveyor belt. Then image processing is done to get required features of fruits such as color and size. Defected fruit is detected based on image pixels. Sorting is done based on color and size. Keywords:Image Recognition, CNN, Machine Learning, Neural Network. ii

Contents Acknowledgement i Abstract ii Index iii List of Figures v List of Tables vi 1 Introduction 1 1.1 Introduction to Project Topic . . . . . 1 1.2 Motivation behind Project Topic . . . . . 1 1.3 Objective of the Work . . . . . 1 1.4 Introduction to CNN . . . . . 2 2 Literature Survey 3 2.1 Computer Based Classification of Diseased Fruit using K-Means and Support Vector Machine [1] . . . . . 3 2.2 Segmentation Techniques for Rotten Fruit detection [2] . . . . . 3 2.3 A Deep Neural Network based disease detection scheme for Citrus fruits [3] 3 2.4 Jackfruit Fruit Damage Classification using Convolutional Neural Network [4] 4 2.5 Detection And Classification Of Apple Diseases using Convolutional Neural Networks [5] 4 2.6

Early Detection of Pomegranate Disease by using Machine Learning and Internet of Things [6] 4 2.7

Fruit Disease Classification and Identification using Image Processing. [7] 4 iii

2.8

Detection and classification of Fruit Diseases using Image Processing and Cloud Computing [8] 4 2.9

FRUIT FRESHNESS DETECTION USING CNN APPROACH [9] . . 5 3 Problem Statement 10 4 Project Requirement Specification 11 5 System Architecture 12 6 UML Diagram 13 7 System Implementation 14 7.1 Pre-Processing . . . . . .

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Chapter 1 Introduction 1.1 Introduction to Project Topic India is an agriculture country. Different types of fruits and vegetables are produced in India. India is at second number after china in production fruits. In India all the preharvest and post-harvest process are done manually with help of labor. Manual process is very time consuming, less efficient so to get accurate result automation in agriculture industry is needed. The post- harvest process includes sorting and grading of fruits. Different quality factors are considered for sorting and grading of fruits. These factors are internal quality factors and external quality factors. The external quality factors are texture, shape, color ,size and volume, and internal quality factors are test, sweetness, flavor, aroma, nutrients, carbohydrates present in that fruit 1.2 Motivation behind Project Topic Most real-life applications can use fruit recognition and classification systems. An image classifier has been trained and tested to identify images of fruits and vegetables. Nevertheless, the problem of developing a fast and reliable fruit detection system persists. This is due to large variability in fruit appearance in the field, including properties of color. 1.3 Objective of the Work • To identify various diseases affecting pomegranate. • To study different image detection techniques based on machine learning. 1

• To design and train the system for disease detection by using machine learning algorithm. • Test and validate the system 1.4 Introduction to CNN Convolutional neural networks are inspired by biological processes in that the pattern of communication between neurons is similar to the arrangement of the visual cortex of animals. Neural network with their amazing ability to retrieve information from complex or indirect data can be used to extract a pattern and detect a more complex tendency that can be seen by other computer techniques. Neural computers use data matching. Neural computers work in a completely different way from normal computer operations. Neural computers are trained (not programmed) to be given a specific initial status (data entry); they separate the input data from one of a number of classes or change the original data in such a way that a particular desirable asset is properly processed. 2

Chapter 2 Literature Survey

Computer Based Classification of Diseased Fruit using K-Means and Support Vector Machine [1] In this research work, the proposed image processing techniques are used for diag- nosing the diseases in fruits and the other research work has proposed how filtering technique is essential in obtaining accurate resulting finding the region of interest in segmentation part. 2.2 Segmentation Techniques for Rotten Fruit detection [2] This kind of segmentation technique is based on the pixels of the image. By studying the various pixels, the rotten portion is detected. After identifying the pixels where the rotten portion is there, a marker is added to distinguish that region. 2.3 A Deep Neural Network based disease detection scheme for Citrus fruits [3] A computer vision-based fruit blemish inspection method will begin with segmenta- tion, followed by extraction of texture characteristics and then lead to the correct gradation of fruits into the corresponding quality categories. 3

2.4 Jackfruit Fruit Damage Classification using Convolutional Neural Network [4] The proposed method consists of the image database, then that images are prepro- cessed after that features are extracted by using k-means clustering. Firstly, some images are used to train the machine learning algorithm and other images are utilized as test images to test the accuracy from the outcome. 2.5 Detection And Classification Of Apple Diseases using Convolutional Neural Networks [5] This paper discusses classifying healthy apples and identifies apple diseases, namely apple blotch, apple scab, and apple rot using Convolutional Neural Network (CNN). 2.6

Early Detection of Pomegranate Disease by using Machine Learning and Internet of Things [6]

The technique identifies the infection at the initial stage by processing the images using MATLAB and provides the required information about the diseases. The cloud database contains the details of leaf, fruit and stem infections and they can be utilized by the farmers at any time using mobile application. And it improves the production and helps the farmers by direct usage. 2.7 Fruit Disease Classification and Identification using Image Processing. [7] In this paper, we have used different types of diseases of apple fruit namely, Rot, Scab and Blotch in order to verify and validate the given approach. 2.8

Detection and classification of Fruit Diseases using Image Processing and Cloud Computing [8]

Detection and classification of Fruit Diseases using Image Processing and Cloud

Com- puting The technique identifies the infection at the initial stage by processing the images using MATLAB and provides the required information about the diseases. The cloud database contains the details of leaf, fruit and stem infections and they can be utilized by the farmers at any time using mobile application. 4

2.9 FRUIT FRESHNESS DETECTION USING CNN APPROACH [9] The main focus is on size, color and existence of defects on citrus fruits. The given experiment is skilled to study the lemons, mandarins and oranges. The study presents a parallel system for estimating size as well as inspecting its surface for diseases. Proposed system is capable of classifying mandarins and lemon correctly with the precision of 93 For tabular representation of literature survey, refer Table 2.1. 5

Table 2.1: Literature Survey Sr. No. Title Methodology Conclusion Limitation 1. Computer Based Classi- fication of Dis- eased Fruit using K- Means and Support Vector Machine [1] the proposed image processing techniques are used for diagnos- ing the diseases in fruits and the other re- search work has pro- posed how filtering technique is essential in obtaining accurate resulting finding the region of interest in segmentation part. Here, the proposed work is concluded by showing the perfor- mance of SVM proves to be the best with an accuracy of 92 percentage when com- pared to other classi- fiers. The model in this paper has a relatively low detection accu- racy on fruit, They are also trying to im- prove detection accuracy. 2. Segmentation Techniques for Rot- ten Fruit detection [2] This kind of segmen- tation technique is based on the pixels of the image. By studying the various pixels, the rotten portion is detected. After identifying the pixels where the rot- ten portion is there, a marker is added to distinguish that region. This paper take tomato as the re- search object, and it is using rgb code and it is using color based segmentation technique. Although the detection model proposed in the article has high detection accuracy, the de- tection speed is slightly slower. 6

3. A Deep Neural Network based disease detection scheme for Citrus fruits [3] A computer vision- based fruit blemish inspection method will begin with seg- mentation, followed by extraction of tex- ture characteristics and then lead to the correct gradation of fruits into the cor- responding quality categories. This paper has proposed a DL methodology for the automated detection and classification of citrus diseases using the process data augmentation and pre-processing. DL works well when there is a wide collection of data. But to get a well-performing model, there is a need to increase the small amount of data that the authors originally collected. The result is based only to identify singled type of disease 7

4. Jackfruit Fruit Damage Classifica- tion using Convo- lutional Neural Network [4] The proposed method consists of the im- age database, then that images are pre- processed after that features are extracted by using k-means clustering. Firstly, some images are used to train the machine learning algorithm and other images are utilized as test images to test the accuracy from the outcome. this study was able to come up a con- volutional neural network model with an application of data augmentation, batch normalization, and dropout techniques. By this implemen- tation, the model obtained an overall success rate of 97.87 when applied on every image in the test dataset. The detection and identifica- tion of the fruit disease through this method may be less accurate. The disease is occurring by viruses is not easy to diagnose by this system. 8

5. Beyond Human Recog- nition: A CNN- Based Frame- work for Hand- written Character Recognition [5] This paper discusses classifying healthy apples and identi- fies apple diseases, namely apple blotch, apple scab, and apple rot using Convolu- tional Neural Network (CNN). This research focuses on classifying the healthy apple and identifies the diseases apple namely apple blotch, apple scab and apple rot. This work shows the efficacy of using CNN. The ex- periment was carried out by dividing the training and testing into different ratio and the selection was random and for each ratio it was run 10 times. We have pro- posed different models of CNN and the best accuracy was achieved by model5 which is 99.17 when the training data set was 90 and the testing data set was 10 . For other training ratios, model5 out- performs other models in term of classification accuracy and time complexity 9

Chapter 3 Problem Statement To design and develop a system for pomegranate fruit disease detection based on machine learning. 10

Chapter 4 Project Requirement Specification • Python, TensorFlow, OpenCv, Flask •

Processor: Intel Dual Core or higher. • Ram: 2GB or higher. • Disk Space: Varies according to datasets and samples. •

Data-sets: https://www.kaggle.com/piyushchoudhary1611/newone-for-pomeogranate- disease 11

Chapter 5

System Architecture In machine learning, a Convolutional neural network (CNN, or ConvNet) is a class of deep neural network, most commonly applied to analyze visual imagery. The following diagram gives us idea about basic CNN architecture. Refer Figure 5.1 for CNN system architecture. Figure 5.1: Basic System Architecture 12

Chapter 6 UML Diagram The use case diagram given below (Figure 6.1) gives an brief visual information about the system which detects fruit disease from the image. Figure 6.1: User Case Diagram for Fruit disease Recognition System 13

Chapter 7 System Implementation

In machine learning, a CNN algorithm is a class of deep neural network, most com- monly used to analyze images. 7.1 Pre-Processing Preliminary processing of the input image is done by converting the given image to a gray scale. Usually a standard color image consists of three channels - a red channel, a green channel, a blue channel commonly known as RGB. Then the color image changes to a gray scale with a single monochrome channel to avoid unwanted noise in the image. The input image provided will be of various sizes which can lead to the loss of accurate prediction when the image is compared to that of a trained convolutional neural network. So the image is resized and resized to a blank image of 224 x 224 pixel. 7.2 Feature Extraction Feature releasing is the process of converting input data into a set of features that can best represent input data. Feature removal is related to size reduction. When input data is too large to be processed, it can then be converted into a reduced set of features (also called element vector). Determining the subset of the first elements is called the element selection. Selected features are expected to contain relevant information from the input details, so that the required work can be done using this reduced caption instead of the full initial data. After resizing the image, the pixel values obtained by the same 1D elements represent values between 255 and 0 depending on the pixel density. Refer figure 7.1 for feature extraction and classification structure. 14 Figure 7.1: Feature Extraction 7.3 The Min-Max Scalar The standard min-max scalar form uses mean and standard deviations to include all data in the range between a certain min min and size. It modifies features by measuring each element in a given range. This rating scale also translates into each individual feature that is at a given level in the training set, e.g. Between zero and 1. This change is often used as an alternative to zero, to measure unit variability. It reduces the width as the width is now between 0 and 1 (or -1 to 1 if there are negative values). 7.4 Image Normalization Normalization is a process that changes the pixel density of the intensity. Normal performance is sometimes called differential stretching or histogram extension. In this image insert normalization is done by removing the background pixels and one character will be provided as it is found in the image. This can be done by using a random value so that the background pixels will have a value less than the pixel values of the character's shadows. In this way the image is usually made to match the image in the Kaggle database. 15 Figure 7.2: Diseases 7.5 Classification Convolutional neural network is used as a feature extractor from an input image. CNN contains input and output layer, as well as many hidden layers. CNN's hidden layers usually consist of convolutional layers, cohesive layers, fully connected layers and standard layers. CNN consists of three main elements which are the convolutional layer, the compound layer and the extraction layer. The most common activation function used by CNN is ReLU representing the Rectified Linear Unit. 16 7.6

Result Figure 7.3: Result These are our trained model results with gradually increasing our model accuracy and decreasing model loss per epochs. 17

Chapter 8 Working Module GUI •

CNN: The CNN layers are fed the input image. These layers have been trained to extract important information from images. There are three operations in each stratum. First, there's the convolution operation, which takes the input and applies a filter kernel of size 32 in the first two layers and 64 in the last three layers. Following that, the non-linear RELU function is used. Finally, a pooling layer condenses image regions and produces a smaller version of the input. While the image height is reduced by two in each layer, feature maps (channels) are added, resulting in a 28640 feature map (or sequence). •

GUI: For the ease of end user, an Web page is implemented in which user can upload image or load image from local drive storage which after processing will show current fruit disease from the image. 18

Chapter 9 Project Plan 19

Chapter 10 Conclusion The system takes an input image of Pomegranate and processes using CNN algorithm by image augmentation and RGB color gradient for further categorising it under different diseases like bacterial blight, butterfly pomegranate, bitter rot and providing preventive measures to the user and system accuracy chart at the client end. 20

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System Architecture In machine learning, a Convolutional neural network (CNN, or ConvNet) is a class of deep neural network, most commonly applied to analyze visual imagery. The following diagram gives us idea about basic CNN architecture. Refer Figure 5.1 for CNN system architecture. Figure 5.1: Basic System Architecture 12			System Architecture In machine learning, a Convolutional neural network (CNN, or ConvNet) is a class of deep neural network, most commonly applied to analyze visual imagery. The following diagram gives us idea about basic CNN architecture. Refer Figure 5.1 for CNN system architecture. Fig 4.1: Basic Architecture		

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In machine learning, a CNN algorithm is a class of deep neural network, most com- monly used to analyze images. 7.1 Pre-Processing Preliminary processing of the input image is done by converting the given image to a gray scale. Usually a standard color image consists of three channels - a red channel, a green channel, a blue channel commonly known as RGB. Then the color image changes to a gray scale with a single monochrome channel to avoid unwanted noise in the image. The input image provided will be of various sizes which can lead to the loss of accurate prediction when the image is compared to that of a trained convolutional neural network. So the image is resized and resized to a blank image of 224 x 224 pixel. 7.2 Feature Extraction Feature releasing is the process of converting input data into a set of features that can best represent input data. Feature removal is related to size reduction. When input data is too large to be processed, it can then be converted into a reduced set of features (also called element vector). Determining the subset of the first elements is called the element selection. Selected features are expected to contain relevant information from the input details, so that the required work can be done using this reduced caption instead of the full initial data. After resizing the image, the pixel values obtained by the same 1D elements represent values between 255 and 0 depending on the pixel density. Refer figure 7.1 for feature extraction and classification structure. 14 Figure 7.1: Feature Extraction 7.3 The Min-Max Scalar The standard min-max scalar form uses mean and standard deviations to include all data in the range between a certain min min and size. It modifies features by measuring each element in a given range. This rating scale also translates into each individual feature that is at a given level in the training set, e.g. Between zero and 1. This change is often used as an alternative to zero, to measure unit variability. It reduces the width as the width is now between 0 and 1 (or -1 to 1 if there are negative values). 7.4 Image Normalization Normalization is a process that changes the pixel density of the intensity. Normal performance is sometimes called differential stretching or histogram extension. In this image insert normalization is done by removing the background pixels and one character will be provided as it is found in the image. This can be done by using a random value so that the background pixels will have a value less than the pixel values of the character's shadows. In this way the image is usually made to match the image in the Kaggle database. 15 Figure 7.2: Diseases 7.5 Classification Convolutional neural network is used as a feature extractor from an input image. CNN contains input and output layer, as well as many hidden layers. CNN's hidden layers usually consist of convolutional layers, cohesive layers, fully

In machine learning, a CNN algorithm is a class of deep neural network, most commonly used to analyze images. 4.2.1 Pre-Processing Preliminary processing of the input image is done by converting the given image to a gray scale. Usually, a standard color image consists of three channels - a red channel, a green channel, a blue channel commonly known as RGB. Then the color image changes to a gray scale with a single monochrome channel to avoid unwanted noise in the image. The input image provided will be of various sizes which can lead to the loss of accurate prediction when the image is compared to that of a trained convolutional neural network. So, the image is resized and resized to a blank image of 28 x 28 pixel. 4.2.2 Feature Extraction Feature releasing is the process of converting input data into a set of features that can best represent input data. Feature removal is related to size reduction. When input data is too large to be processed, it can then be converted into a reduced set of features (also called element vector). Determining the subset of the first elements is called the element selection. Selected features are expected to contain relevant information from the input details, so that the required work can be done using this reduced caption instead of the full initial data. After resizing the image, the pixel values obtained by the same 1D elements represent values between 255 and 0 depending on the pixel density. Refer figure 7.1 for feature extraction and classification structure. Figure 4.2.1: Feature Extraction 4.2.3 The Min-Max Scalar The standard min-max scalar form uses mean and standard deviations to include all data in the range between a certain min min and size. It modifies features by measuring each element in a given range. This rating scale also translates into each individual feature that is at a given level in the training set, e.g., Between zero and1. This change is often used as an alternative to zero, to measure unit variability. It reduces the width as the width is now between 0 and 1 (or -1 to 1 if there are negative values. 4.2.4 Image Normalization Normalization is a process that changes the pixel density of the intensity. Normal performance is sometimes called differential stretching or histogram extension. In this image insert normalization is done by removing the background pixels and one character will be provided as it is found in the image. This can be done by using a random value so that the background pixels will have a value less than the pixel values of the character's shadows. In this way the image is usually made to match the image in the EMNIST database. In this image, pixel values are greater than 0. Figure 4.2.2: Letter 'A' 4.2.5 Classification Convolutional neural network is used as a separator to separate a handwritten char- acter from an input image. CNN contains input and output layer, as well as many hidden layers. CNN's hidden

connected layers and standard layers. CNN consists of three main elements which are the convolutional layer, the compound layer and the extraction layer. The most common activation function used by CNN is ReLU representing the Rectified Linear Unit. 16 7.6

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CNN: The CNN layers are fed the input image. These layers have been trained to extract important information from images. There are three operations in each stratum. First, there's the convolution operation, which takes the input and applies a filter kernel of size 32 in the first two layers and 64 in the last three layers. Following that, the non-linear RELU function is used. Finally, a pooling layer condenses image regions and produces a smaller version of the input. While the image height is reduced by two in each layer, feature maps (channels) are added, resulting in a 28640 feature map (or sequence). •

CNN: The CNN layers are fed the input image. These layers have been trained to extract important information from images. There are three operations in each stratum. First, there's the convolution operation, which takes the input and applies a filter kernel of size 55 in the first two layers and 33 in the last three layers. Following that, the non-linear RELU function is used. Finally, a pooling layer condenses image regions and produces a smaller version of the input. While the image height is reduced by two in each layer, feature maps (channels) are added, resulting in a 32256-feature map (or sequence). 6.3

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