A

Major Project

On

Quality Detection of Fruits and Vegetables using AI

(Submitted in partial fulfillment of the requirements for the award of Degree)

BACHELOR OF TECHNOLOGY

In

COMPUTER SCIENCE AND ENGINEERING

By

MAMINDLA MARUTHI (197R1A05M6)
NANJALA SAMPATH KUMAR (197R1A05N5)
SEGGAM AKHILA (197R1A05P5)

Under the Guidance of

Dr. PRABHU A

(Associate Professor)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CMR TECHNICAL CAMPUS

UGC AUTONOMOUS

(Accredited by NAAC, NBA, Permanently Affiliated to JNTUH, Approved by AICTE, New Delhi) Recognized Under Section 2(f) & 12(B) of the UGCAct.1956, Kandlakoya (V), Medchal Road, Hyderabad-501401.

2019-2023

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that the project entitled **" Quality Detection of Fruits & Vegetables using AI"** being submitted by **MAMINDLA MARUTHI (197R1A05M6), NANJALA SAMPATH KUMAR (197R1A05N5), SEGGAM AKHILA (197R1A05P5)** in partial fulfillment of the requirements for the award of the degree of B.Tech in Computer Science and Engineering to the CMR Technical Campus, is a record of bonafide work carried out by them under our guidance and supervision during the year 2022-2023.

The results embodied in this thesis have not been submitted to any other University or Institute for the award of any degree or diploma.

Dr. Prabhu A
(Associate Professor)
INTERNAL GUIDE

Dr. A. Raji Reddy
DIRECTOR

Dr. K. Srujan Raju
HOD

EXTERNAL EXAMINER

Submitted for viva voice Examination held on _____

ACKNOWLEDGEMENT

Apart from the efforts of us, the success of any project depends largely on the encouragement and guidelines of many others. We take this opportunity to express our gratitude to the people who have been instrumental in the successful completion of this project.

We take this opportunity to express our profound gratitude and deep regard to our guide **Dr.Prabhu A**, Associate Professor for his exemplary guidance, monitoring and constant encouragement throughout the project work. The blessing, help and guidance given by him shall carry us a long way in the journey of life on which we are about to embark.

We also take this opportunity to express a deep sense of gratitude to the Project Review Committee (PRC) **Dr. Punyaban Patel, Ms. Shilpa, Dr. T. Subha Mastan Rao & J. Narasimha Rao** for their cordial support, valuable information and guidance, which helped us in completing this task through various stages.

We are also thankful to **Dr. K. Srujan Raju**, Head of the Department of Computer Science and Engineering, **Dr. Ashuthosh Saxena**, Dean R&D, and **Dr. D T V Dharmajee Rao**, Dean Academics for providing encouragement and support for completing this project successfully.

We are obliged to **Dr. A. Raji Reddy,** Director for being cooperative throughout the course of this project. We also express our sincere gratitude to Sri. **Ch. Gopal Reddy,** Chairman for providing excellent infrastructure and a nice atmosphere throughout the course of this project.

The guidance and support received from all the members of **CMR Technical Campus** who contributed to the completion of the project. We are grateful for their constant support and help.

Finally, we would like to take this opportunity to thank our family for their constant encouragement, without which this assignment would not be completed. We sincerely acknowledge and thank all those who gave support directly and indirectly in the completion of this project.

MAMINDLA MARUTHI (197R1A05M6)

NANJALA SAMPATH KUMAR (197R1A05N5)

SEGGAM AKHILA (197R1A05P5)

ABSTRACT

Automation of fruit classification is an interesting application of computer vision. Traditional fruit classification methods have often relied on manual operations based on visual ability and such methods are tedious, time consuming and inconsistent. External shape appearance is the main source for fruit classification. In recent years, image processing techniques have been used in the fruit industry drastically, especially for applications in quality inspection and colour, size, shape sorting. Research in this area indicates the feasibility of using machine vision systems to improve product quality while freeing people from the traditional hand sorting of fruits. This project deals with various image processing techniques used for fruit classification.

LIST OF FIGURES/TABLES

LIST OF SCREENSHOTS

TABLE OF CONTENTS

1. INTRODUCTION

1. INTRODUCTION

1.1 PROJECT SCOPE

The proposed system takes the input from the local directory using data Image Generator we do data augmentation as per the required model to train the model and predict. Then the image is converted to an numpy array to train the data accordingly and predict the image weather it is fresh or rotten as per the input The score of this project/application is limited to, the following actions:

- Fetching the New image for the user from local directory
- Applying the encoding for the given image
- Applying the train for the given image dataset
- Providing an output as per the quality of the fruit given in input

1.2 PROJECT PURPOSE

Determining the disease occurred to fruits and vegetables. The kind of infections they are, such as fungal, bacterial and viral. Analyzing the severity of the disease and its impact and classifying the fruits and vegetables into specific quality levels. They are mainly three levels of poor , average and good quality fruit Covering all the major fruits and vegetables cultivated in India. The fruits and vegetables which Indians use in their daily routine majorly. Determining the causes of having poor quality vegetables and fruits. And warnings will be generated according to the quality Quality Defined The composite of those characteristics that differentiate individual units of a product, and have significance in determining the degree of acceptability of that unit to the user .It’s a term which denotes a degree of excellence, a high standard or value . Instrumental techniques for estimating appearance(size, shape), variety in products of the soil.

1.3 PROJECT FEATURES

The main features of this project are analyzing the severity of the disease and its impact and classifying the fruits and vegetables into specific quality level using image processing there involves many steps in quality detection of fruits & vegetables are

1. Data Collection
2. Data Preprocessing
3. Training And Testing
4. Modeling
5. Predicting

2. SYSTEM ANALYSIS

1. SYSTEM ANALYSIS

SYSTEM ANALYSIS

System Analysis is the important phase in the system development process. The System is studied to the minute details and analyzed. The system analyst plays an important role of an interrogator and dwells deep into the working of the present system. In analysis, a detailed study of these operations performed by the system and their relationships within and outside the system is done. A key question considered here is, “what must be done to solve the problem?” The system is viewed as a whole and the inputs to the system are identified. Once analysis is completed the analyst has a firm understanding of what is to be done.

1.1 PROBLEM DEFINITION

One of the significant areas of the Indian Economy is Agriculture. Work to practically half of the nation's labor force is given by the Indian horticulture area. Rancher's monetary development relies upon the nature of the items that they produce, which depends on the plant's development and the yield they get. Therefore, in the field of agriculture, detection of disease in Fruits and Vegetables plays an instrumental role. In many small-scale industries, they still use the old-fashioned method of manual observing and categorizing of fruits. But this method is very time consuming and the production will slow down. The proposed system used reduces the human effort and increases the production.

2.2 EXISTING SYSTEM

In the past decades, Profound learning-based characterizations are making it possible to recognize fruits from pictures. However, fruit recognition is still a problem for the stacked fruits on a weighing scale because of the complexity and similarity.

2.2.1 LIMITATIONS OF EXISTING SYSTEM

- Limited accuracy: The accuracy of the fruit classification system may be limited by the quality of the acquired images and the effectiveness of the image preprocessing and feature extraction techniques used. It may be difficult to accurately classify fruits that have similar colors or textures, or fruits that are partially obscured in the image.
- Limited fruit types: The fruit classification system may be limited to a specific set of fruit types that have distinct features that can be easily differentiated using the image processing techniques used. It may be difficult to classify fruits that have similar features or that are not included in the training dataset.
- Limited scalability: The fruit classification system may be limited in its scalability due to the computational resources required to process large amounts of image data in real-time. This may limit the system's ability to handle large volumes of fruit sorting and grading tasks or to operate in a high-speed production environment.

2.3 PROPOSED SYSTEM

The proposed system for quality detection for fruits and vegetables using AI will aim to accurately determine the quality of fruits and vegetables based on their appearance, size, shape, and other relevant characteristics. The system will acquire high-quality images of fruits and vegetables using a camera or other imaging device and use data augmentation techniques to increase the size and diversity of the image dataset. The system will then use image preprocessing techniques such as encoding and normalization to enhance the quality of the acquired images and prepare them for training. The system will use AI algorithms such as deep learning to train a model on the image dataset, and then use the trained model to classify the fruits and vegetables into specific quality levels, such as poor, average, and good. The results will be displayed to the user through a user-friendly interface, which will also allow users to easily upload images of fruits and vegetables and receive warnings if poor quality is detected. The system will also have a database to store the acquired images and their corresponding quality classification results for future reference and analysis.

The proposed system will be continuously improved by incorporating feedback from users, analyzing the quality classification results, and incorporating new image processing techniques and algorithms to improve the accuracy and efficiency of the fruit and vegetable quality detection process.

2.3.1 ADVANTAGES OF THE PROPOSED SYSTEM

- Improved accuracy: The system uses AI algorithms and image processing techniques to accurately detect the quality of fruits and vegetables, resulting in a more reliable and consistent assessment of their quality.
- Increased efficiency: The system is designed to process fruit and vegetable images in real-time, allowing for rapid and accurate quality detection. This can improve the efficiency of fruit and vegetable quality assessment in a production environment.
- Reduced waste: The system can help reduce waste by identifying poor quality fruits and vegetables early in the production process, allowing for timely intervention and reducing the likelihood of spoilage.
- User-friendly interface: The system has a user-friendly interface that makes it easy for users to upload images of fruits and vegetables, view the quality classification results, and receive warnings if poor quality is detected. This can improve the usability and accessibility of the system for a wider range of users.

2.4 FEASIBILITY STUDY

The feasibility of the project is analyzed in this phase and a business proposal is put forth with a very general plan for the project and some cost estimates. During system analysis the feasibility study of the proposed system is to be carried out. This is to ensure that the proposed system is not a burden to the company. Three key considerations involved in the feasibility analysis:

- EconomicFeasibility
- TechnicalFeasibility
- SocialFeasibility

2.4.1 ECONOMIC FEASIBILITY

The developing system must be justified by cost and benefit. Criteria to ensure that effort is concentrated on a project, which will give best, return at the earliest. One of the factors, which affect the development of a new system, is the cost it would require. The following are some of the important financial questions asked during preliminary investigation:

- The costs conduct a full system investigation.
- The cost of the hardware and software.
- The benefits in the form of reduced costs or fewer costly errors.

Since the system is developed as part of project work, there is no manual cost to spend for the proposed system. Also all the resources are already available, it gives an indication that the system is economically possible for development.

2.4.2 TECHNICAL FEASIBILITY

This study is carried out to check the technical feasibility, that is, the technical requirements of the system. Any system developed must not have a high demand on the available technical resources. The developed system must have a modest requirement, as only minimal or null changes are required for implementing this system.

2.4.3 BEHAVIORAL FEASIBILITY

This includes the following questions:

- Is there sufficient support for the users?
- Will the proposed system cause harm?

The project would be beneficial because it satisfies the objectives when developed and installed. All behavioral aspects are considered carefully and conclude that the project is behaviorally feasible

2.5 HARDWARE & SOFTWARE REQUIREMENTS

2.5.1 HARDWARE REQUIREMENTS:

Hardware interfaces specify the logical characteristics of each interface between the software product and the hardware components of the system. The following are some hardware requirements.

- System: I5 Processor & basic GPU
- Hard disk: 500 GB
- RAM: 8 GB
- Input device: Standard Keyboard and Mouse
- Output device: VGA and High-resolution Monitor

2.5.2 SOFTWARE REQUIREMENTS:

Software Requirements specifies the logical characteristics of each interface and software components of the system. The following are some software requirements,

- Operating system : Windows 10
- Languages : Python
- Tools : VS Code

3. ARCHITECTURE

2. ARCHITECTURE

2.1 PROJECT ARCHITECTURE

This project architecture shows the procedure followed for classification, starting from input to final prediction.

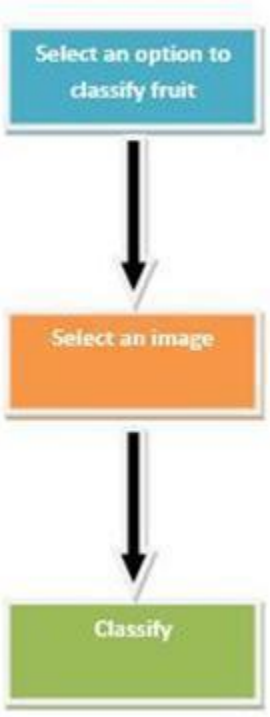


Figure 3.1: Architecture of prediction model

DESCRIPTION

In the training phase of the model, after creating the dataset for the model to train, the dataset images are pre-processed which is needed for eliminating the unwanted information from the image. Using image processing techniques, higher accuracy can be obtained from the given images. In the pre-processing step, the images are first normalized through normalization for reducing the data loss of the images, and then the images are introduced to data augmentation for diversifying and increasing the dataset size when the classifier is trained. After the preprocessing, the features like color, shape, size, texture, etc., are extracted from the images. The extracted features are used to train the classifier. The proposed system uses Convolutional Neural Networks (CNN), a deep learning algorithm, which consists of a class of neural networks as a classifier for image recognition by a specialized way of processing on the grid of pixels. This process trains the system for classifying and grading. For the training phase, the images of the dataset consist of fresh and stale classes of every fruit and vegetable.

3.2 USE CASE DIAGRAM

In the use case diagram, we have basically one actor who is the user in the trained model. A use case diagram is a graphical depiction of a user's possible interactions with a system. A use case diagram shows various use cases and different types of users the system has. The use cases are represented by either circles or ellipses. The actors are often shown as stick figures.

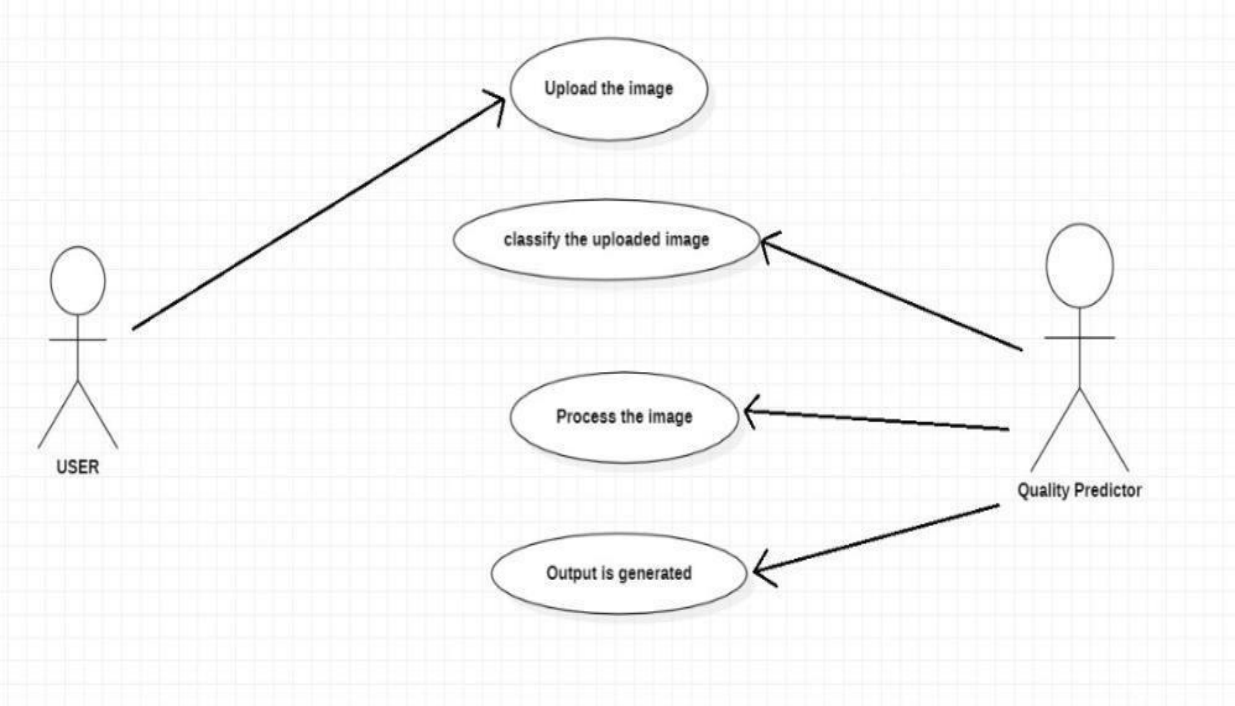


Figure 3.2: Use Case Diagram

3.3 CLASS DIAGRAM

Class diagram is a type of static structure diagram that describes the structure of system by showing the system's classes, their attributes, operations(or methods), and the relationships among objects.

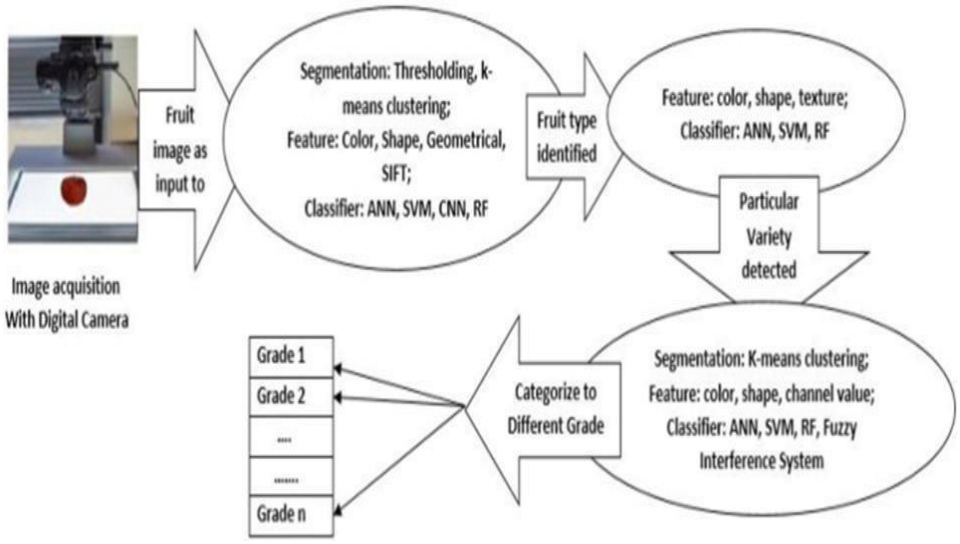


Figure 3.3: Class Diagram

3.4 SEQUENCE DIAGRAM

A sequence diagram shows object interactions arranged in time sequence. It depicts the objects involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. Sequence diagrams are typically associated with use case realizations in the logical view of the system under development.

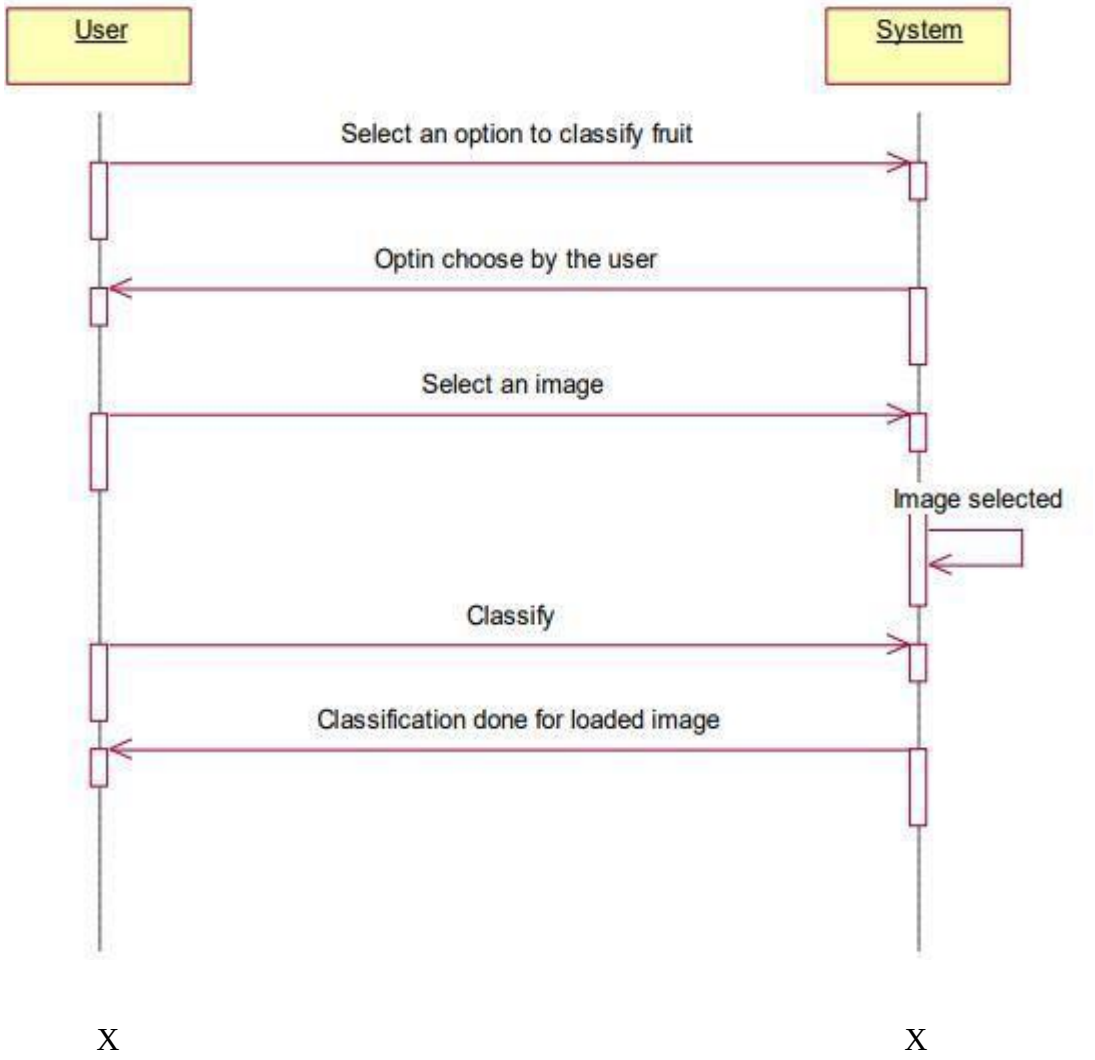


Figure 3.4: Sequence Diagram

3.5 ACTIVITY DIAGRAM

Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. They can also include elements showing the flow of data between activities through one or more data.

Figure 3.5: Activity Diagram for Quality detection of fruits and vegetables using AI

4. IMPLEMENTATION

4.1 SAMPLE CODE

```
import os
import sys
import numpy as np
from flask import Flask, render_template, request
from werkzeug.utils import secure_filename
from tensorflow.keras.preprocessing import
image from tensorflow.keras.models import
load_model from PIL import Image, ImageFile
import my_tf_mod
from io import BytesIO
import matplotlib.pyplot as plt
import base64
app = Flask(__name__)
@app.route('/')
def home():
    return render_template('home.html')
@app.route('/Prediction', methods=['GET','POST'])
def pred():
    if request.method=='POST':
        file = request.files['file']
        org_img, img= my_tf_mod.preprocess(file)
        print(img.shape)
        fruit_dict=my_tf_mod.classify_fruit(img)
        rotten=my_tf_mod.check_rotten(img)
        img_x=BytesIO()
        plt.imshow(org_img/255.0)
        plt.savefig(img_x,format='png')
        plt.close()
        img_x.seek(0)
        plot_url=base64.b64encode(img_x.getvalue()).decode('utf8')
    return render_template('Pred3.html', fruit_dict=fruit_dict, rotten=rotten, plot_url=plot_url)
    if __name__==’_main_’:
         app.run(debug=True)
```

Home page

```
<html>
<body>
<div class="container">
  <div class="jumbotron" >
    <h1 class="display-4">Hello, Buddy!</h1>
    <p class="lead">This web platform is made using <strong>Flask</strong> API. Serving Predictive model at your fingertips.</p>
    <hr class="my-4">
    <p>Models are trained for predicting perticular Fruit and also checking their quality in given image using various <strong>Deep Learning</strong> techniques.</p>
  </div>
</div>
<div class="container">
  <p>
    <button class="btn btn-primary" type="button" data-toggle="collapse" data-target="#collapseExample" aria-expanded="false" aria-controls="collapseExample">
      About Page
    </button>
  </p>
  <div class="collapse" id="collapseExample">
    <div class="card card-body" align='left'>
      A simple Deep neural network model trained on real world images of 1.Apples, 2.Bananas, 3.Oranges . <br>
      By tapping below you can upload any image under checked condition below.<br><br>
      Output by clicking on "Submit and Predict" button:
      <ul>
        <li><strong>Visualization of probabilities for each fruit class made by Classifier/Model.</strong> </li>
        <li><strong>Also, predicts the probability of Fruit been Fresh or Rotten</strong></li>
      </ul>
        </div>
  </div>
```

```
 <form action="{{url_for("pred")}}" method="POST" enctype="multipart/form-data">
   <h4>Click below to upload your <strong>image</strong>.</h4>
   <div class="form-group">
   <!-- <img src="../static/upload5.png" alt="img" width="20%" height="5%"> -->
   <label>
   <input type="file" name="file" id="file" style="display:none" accept="image/*"
   required> <img src="../static/upload5.png" width="50%"> </label>
 </div>
   <div class="container">
     <div class="form-group form-check">
     <input type="checkbox" class="form-check-input" id="exampleCheck1" required>
     <label class="form-check-label" for="exampleCheck1">Make sure you uploaded images
related to <strong>1. Apples</strong>, <strong>2. Bananas</strong>, <strong>3.
Oranges</strong></label>
   </div>
   </div>
 <br>
 <input type="submit" class="btn btn-secondary" name="Submit and predict" value="Submit
and Predict"> </form>
  <br>
</div>
</body>
</html>
```

5. RESULT

5.1 STRATEGY

Using different types of algorithm and techniques

5.2 OUTPUT SNAPSHOTS

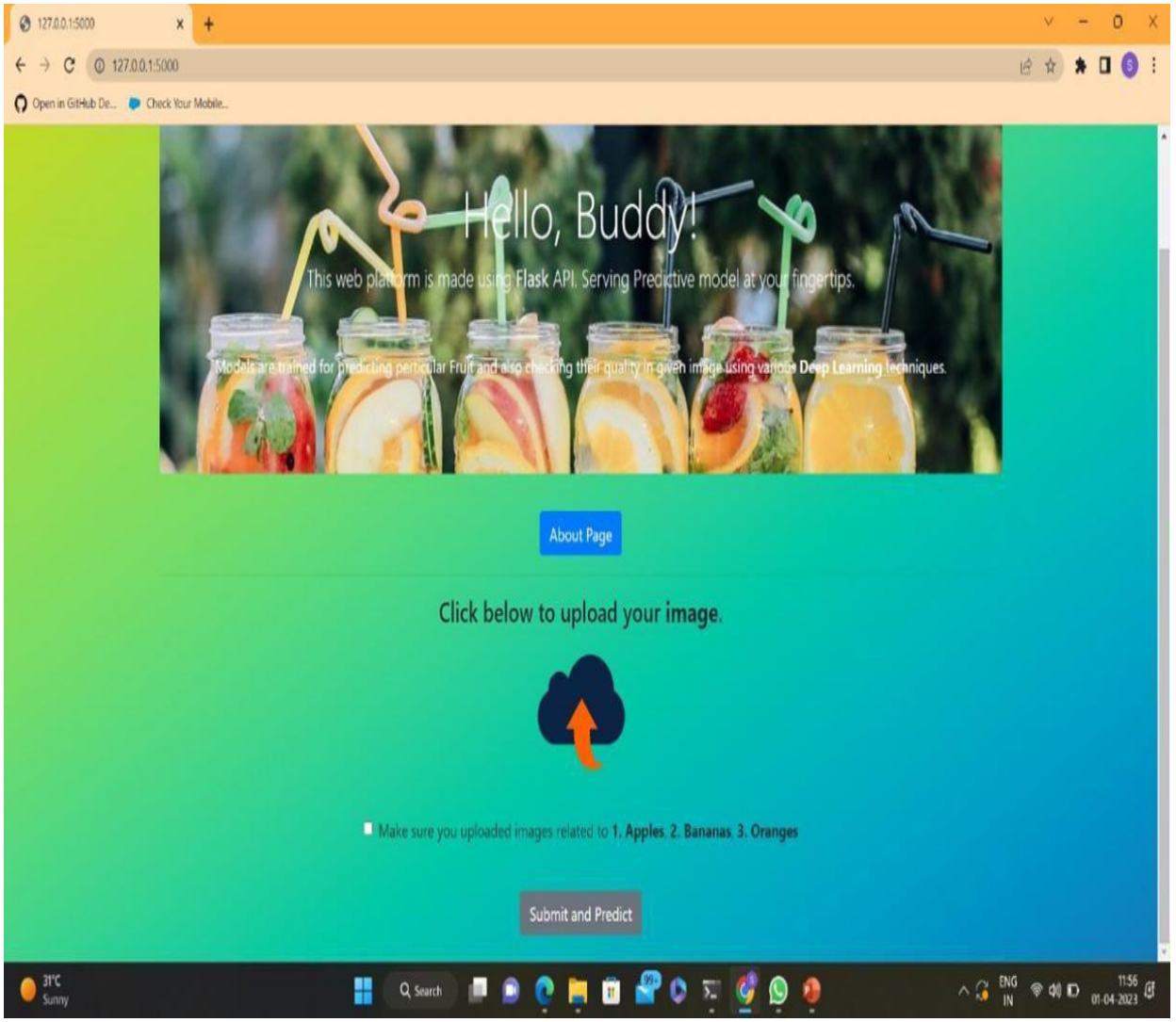


Figure 5.1:Screenshot of Home Screen

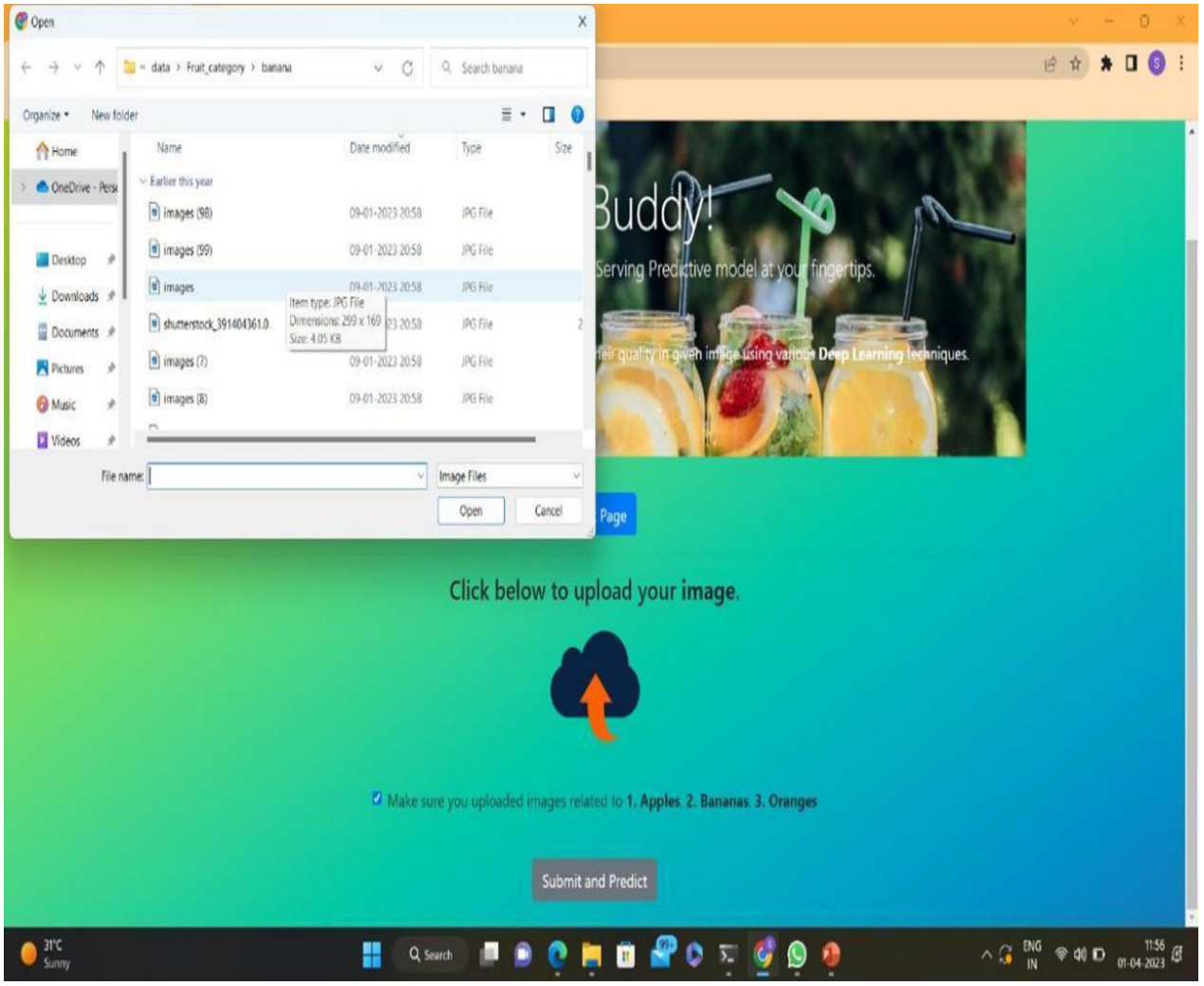


Figure 5.2:Giving input as Image

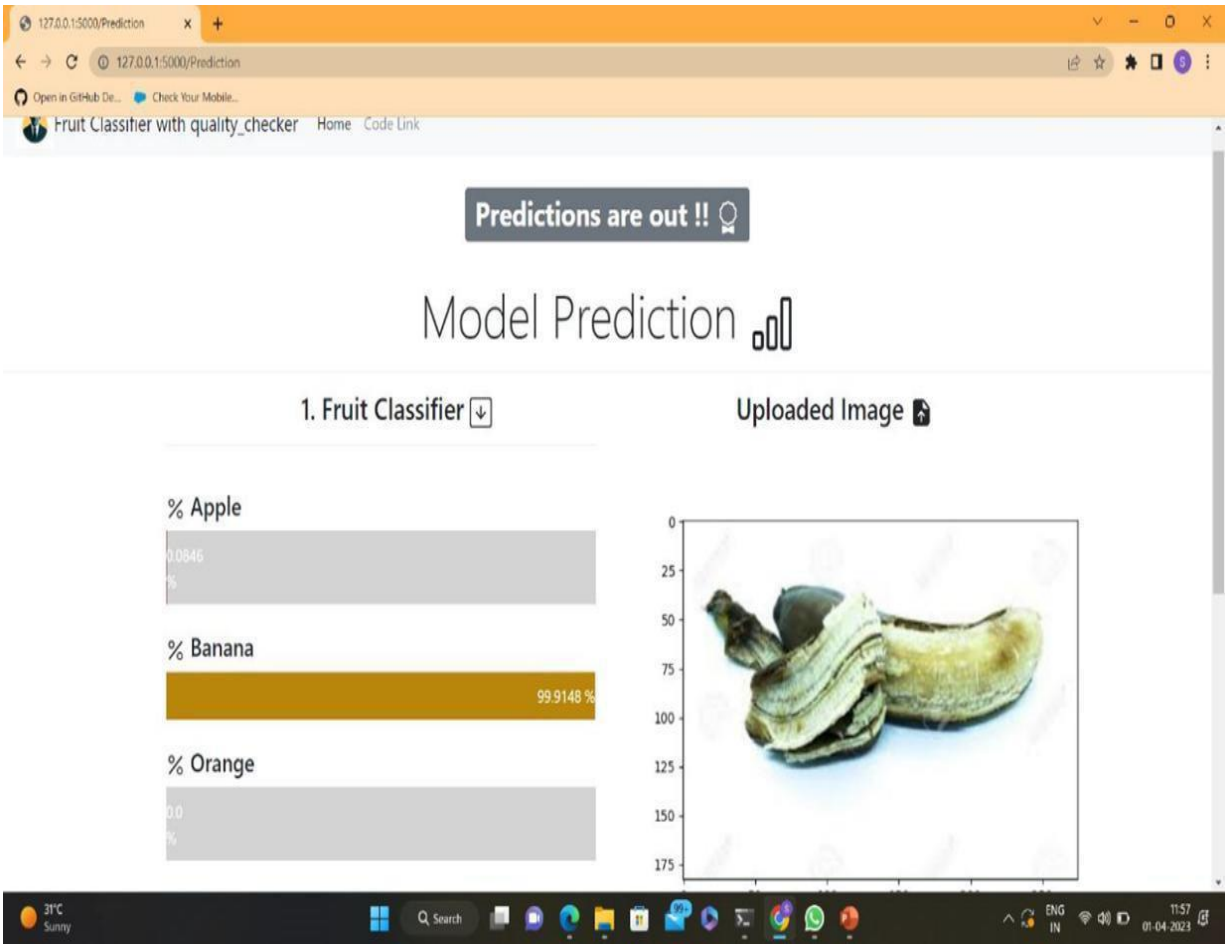


Figure 5.3:Screenshot of Prediction page

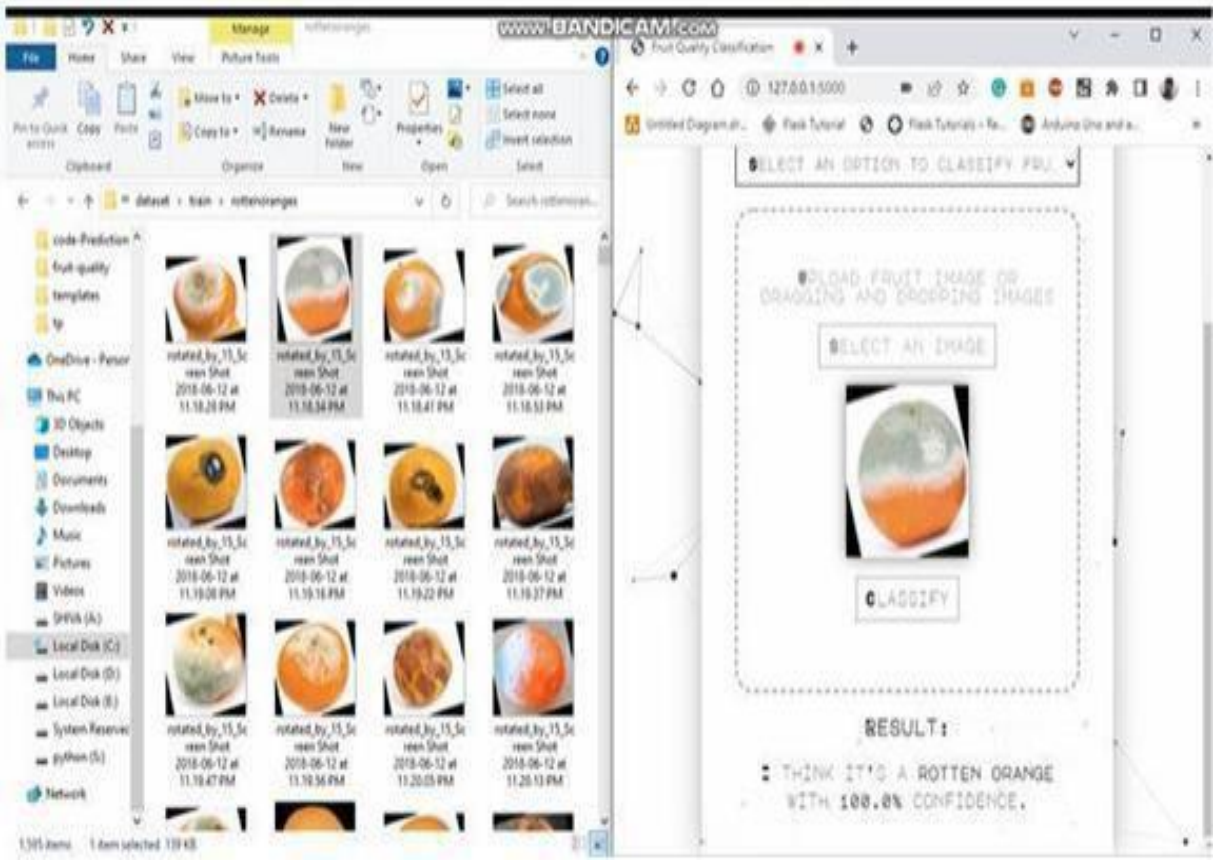


Figure 5.4: Screenshot of output page 1

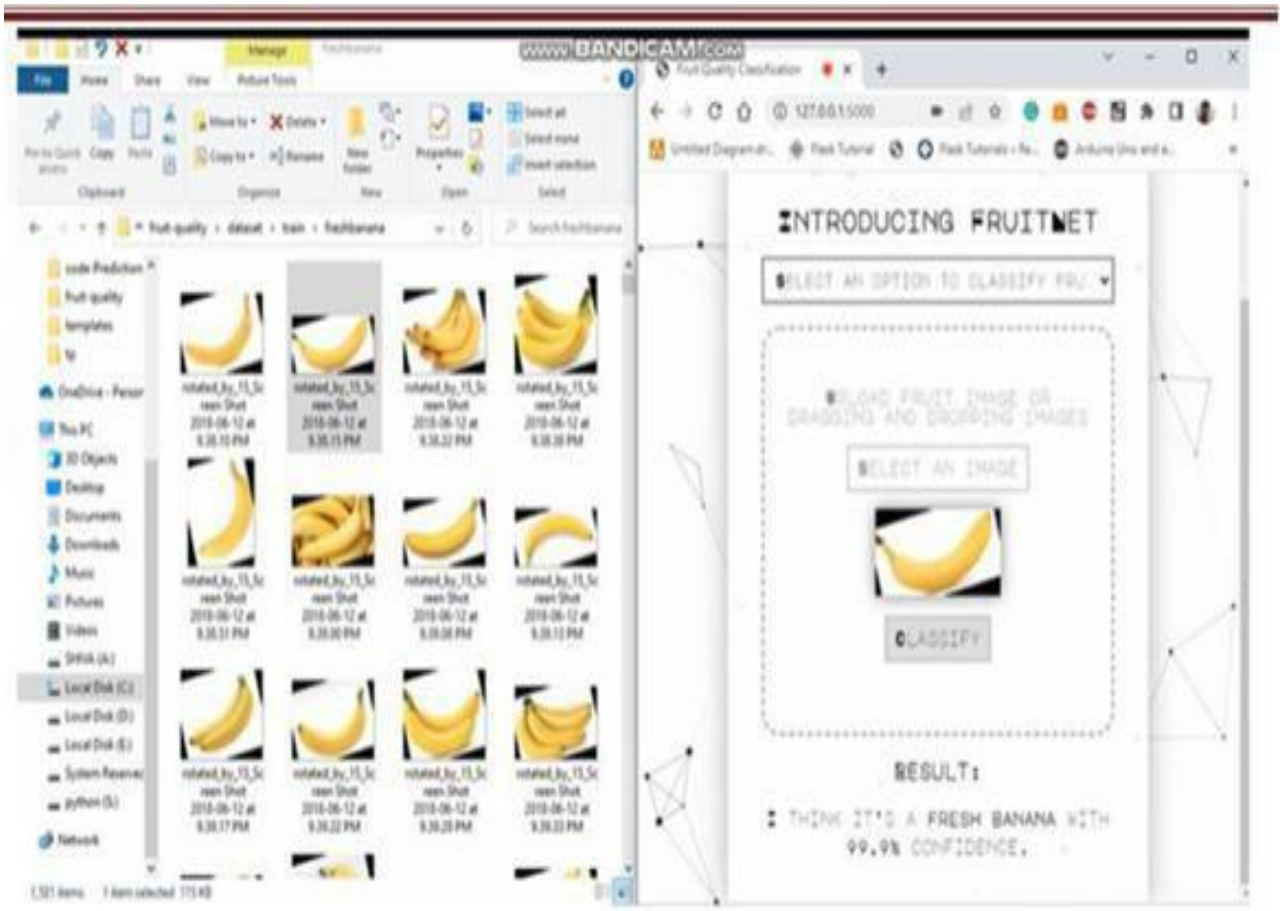


Figure 5.5: Screenshot of output page 2

6. TESTING

6. TESTING

6.1 INTRODUCTION TO TESTING

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, subassemblies, assemblies and/or a finished product. It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of tests. Each test type addresses a specific testing requirement.

6.2 TYPES OF TESTING

6.2.1 UNIT TESTING

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .It is done after the completion of an individual unit before integration. This is a structural testing that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

6.2.2 INTEGRATION TESTING

Integration tests are designed to test integrated software components to determine if they actually run as one program. Integration tests demonstrate that although the components were individually satisfactory, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

6.2.3 FUNCTIONAL TESTING

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:

Valid Input	: Identified classes of valid input must be accepted.
Invalid Input	: Identified classes of invalid input must be rejected.
Functions	: Identified functions must be exercised.
Output	: Identified classes of application outputs must be exercised.

Systems/Procedures: interfacing systems or procedures must be invoked. Organization and preparation of functional tests is focused on requirements, key functions, or special test cases.

7. CONCLUSION

7. CONCLUSION & FUTURE SCOPE

7.1 CONCLUSION

This paper investigates an organic products order. The exactness and misfortune bends were created by involving different blends of stowed away layers for five cases utilizing organic products 360 dataset. This paper bargains different strategies and calculations utilized for organic product acknowledgment and grouping in view of PC vision approach.

Ideally, later on, can be expanded the work with a bigger dataset having more classifications natural products and vegetables.. Have the arrangement to execute some other CNN based models to analyze the precision on the equivalent dataset. Can be additionally work on a few additional highlights for reviewing and characterization, which can recognize kinds of infection as well as surface construction of natural products. Every one of these are future bearing.

7.2 FUTURE SCOPE

This system can be installed in a robot for checking the quality of the fruits and vegetables in the markets. This application system can be used as an information system between customers and shops such as markets, where the products can be graded and uploaded to the database from where the customer can get the required product within the shortest time.

8. BIBLIOGRAPHY

8. BIBLIOGRAPHY

8.1 REFERENCES

[1] Xiaoyang Liu, Dean Zhao,Weikuan jia, Wei Ji, Yueping Sun, “A Detection Method for Apple Fruits Based on Color and Shape Features” , IEEE Access, 22 May 2019 , 67923-67933.

[2] Nishat Tasnim, Md. Romyull Islam, and Shaon Bhatta Shuvo “A Convolution Neural Network Based Classification Approach for Recognizing Traditional Foods of Bangladesh from Food Images” 844-852.

[3] Sahu, Dameshwari, and Chitesh Dewangan. "Identification and Classification of Mango Fruits Using Image Processing ,131-135.

[4] Shiv Ram Dubey and Anand Singh Jalal "Application of Image Processing in Fruit and Vegetable Analysis” A Review 405-424.

[5] Kavdır, I., Guyer, D.E.: Comparison of Artificial Neural Networks and Statistical Classifiers in Apple Sorting using Textural Feature,. Biosystems Engg. 89, 331-344 (2004).

[6] Hannan M.W., Burks T.F., Bulanon D.M., “A Machine Vision Algorithm for Orange Fruit Detection”, Agricultural Engineering International: the CIGR E journal, vol-XI,Pages:1-7, December-2009.

8.2 GITHUB LINK

https://github.com/maruthim34/QualityDetectionofFruitsusingAI

9.PAPER PUBLICATION

A NOVEL IMAGE PROCESSING BASED FRUIT QUALITY DETECTION SYSTEM USING DEEP LEARNING

[1] MAMINDLA MARUTHI, [2] NANJALA SAMPATH KUMAR , [3] SEGGAM AKHILA , [4] Dr. PRABHU A

[1,2,3] B. Tech Student, Dept. of CSE, CMR Technical Campus, Medchal, Hyderabad, Telangana,India,maruthimamindla34@gmail.com,chowdarysampath65@gmail.com, akhila.seggam2003@gmail.com

[4] Associate Professor, Dept. of CSE, CMR Technical Campus, Medchal, Hyderabad, Telangana, India, prabhu.cse@cmrtc.ac.in

ABSTRACT: Intake of healthy fruits and vegetables is vital as they are the source of energy for all living beings. There is an increasing demand for quality in all the consumed food items. Nowadays, starting from consumers, retailers to food manufacturing companies are inspecting food visually for its quality. This manual process incurs more time and it is a laborious and tiring task. So, there is a demand for an automated process which quickly examines, detects the defects and sorts them according to quality. Traditional fruit classification methods have often relied on manual operations based on visual ability and such methods are tedious, time consuming and inconsistent. Fruit Analysis using image processing is a technique used for finding the detection of fruits by a specific algorithm. In recent years, image processing and Deep Learning (DL) techniques have been found increasingly useful in the fruit industry, especially for applications in quality inspection and color, size, shape sorting. Hence in this work, a novel image processing based fruit quality detection system using deep learning is presented. Convolutional Neural Network (CNN) is used to determine the quality of fruits.

KEYWORDS: Fruits, quality, Image Processing, Deep Learning and Convolutional Neural Network.

I. INTRODUCTION

In the field of agriculture and food processing, quality evaluation is a significant parameter to increase benefits and accommodations for individual life. The presence of diseases and pesticides is additionally the major factor that emerges the need for quality evaluation. Food Quality Checking is an essential thing to get rid of food poisoning and diseases, Monitoring the decayable products, and deterioration of fruit at their early stage will decrease the loss of fruit wastage and ensure freshness [1]. Although it can be done manually, some inconsistencies and high costs led to the invention of automatic systems. The automation makes the same process more consistent and time-efficient. Fruit quality detection identifies the defects in fruits by uploading fruit images to the system [4].

One of the largest economic sectors is agriculture and it plays the vital role in economic growth of India. Fruits provide an essential role as a food in our everyday life. It provides nutrients vital for our health and maintenance of our body. Those who eat more fruits as a part of a healthy diet are likely to have reduced risk of some chronic diseases. However, not all fruits are treated equally and it is a matter of concern that not every person knows about every fruit well Still in India, the traditional examination of fruits is performed by human specialist. A large amount of time and money is wasted in the fields for checking the freshness of the fruits by humans [6].

Fruit Recognition and ripen status is useful to the industrial purpose for recognising the fruit and checking the status of the fruit ripe. It is importantly helpful in fruit shop, market and malls to recognising the name of the fruit and categorise the fruit status like low, medium high. farming provides a living for more than 60% of the population. Nowadays, the growth of fruit

productivity is usually influenced by quality. In the industry field, quality is a major issue. Most fruits are low, medium and high ripe to classify the fruits and status of fruit with quality effected by the climate [2].

The fruit's color plays a crucial role for consumers in setting their expectations regarding the likely taste of the fruit. Similarly, to color, the shape of the fruit also plays an important role to determine the quality, quantity and value of the fruits. However, the identification of fruit only has been done by the visual judgement and it has not yet been well defined. The shape can be used to differentiate the taste and quality of the fruit [5].

Hence, classification of fruit freshness is very important, for increasing the market share and establishing a better quality standards. If the classification and grading is done through manual methods, the process will be slow and sometimes it will be full of errors. The humans classify fruits freshness based on color, size, etc. If these quality measures are mapped into automated system by using suitable programming language then the work will be faster and without errors. This results in increasing speed and decreasing cost in fruit sorting process. Till now, many researchers have used different techniques for quality detection based on image features and have worked on the improvement of quality parameters.

With the help of Artificial Intelligence (AI) and Machine Learning (ML) this research can develop an automatic fruit classification system with an information dataset of each fruit [3]. These methodologies may improve the fruit quality cautionary process's value and time potency. Machine vision techniques are currently wide to discover the quality of fruits. Although many researchers have used machine vision technologies, there is still a significant need to develop a more accurate, reliable and automated sorting machines. In addition to that, both accuracy and reliability are yet to be achieved.

Deep Learning is the sub-field of Machine Learning, which is the sub-field of Artificial Intelligence. It is a collection of techniques that model high-level abstractions in data. In deep learning, a computer-based statistical model understands and learns from pictures, sound, or text to conduct analysis. These models can attain state-of-the-art accuracy, sometimes exceeding human-level performance. Models are trained by using a large set of labeled data and neural network architectures that contain many layers in term of accuracy. Recently, deep learning techniques have been found progressively useful in the fruit industries, mainly for the applications in fruit freshness detection.

Hence in this work, a novel image processing based fruit quality detection system using deep learning is presented. The rest of the work is organized as follows: The section II describes the literature survey. The section III presents a novel image processing based fruit quality detection system using deep learning. The section IV presents the result analysis. Finally the section V provides the conclusion.

II. LITERATURE SURVEY

Mohammed Faisal, Fahad Albogamy, Hebah Elgibreen, Mohammed Algabri, And Fattoh Abdu Alqershi et. al., [7] describes Deep Learning and Computer Vision for Estimating Date Fruits Type, Maturity Level, and Weight", smart harvesting decision system to estimate date fruits type, maturity level, and weight using computer vision (CV) and deep learning (DL) techniques. This system consists of three sub-systems: Dates maturity estimation system (DMES), type estimation system (DTES), and dates

weight estimation system (DWES). We utilized four DL architectures, including ResNet, VGG-19, Inception-V3, and NASNet for both DMES and DTES and support vector machine (SVM) (regression and linear) for DWES. The performance of this system is evaluated using the dataset collected by the Center of Smart Robotics Research. DWES achieved a maximum performance of 84.27% using SVM-Linear.

S. Krishna Kumar, J. Kaviya, G. Dilip Prakash, K. Srinivasan et. al., [8] describes Fruit quality detection using machine vision techniques. The process starts by capturing the image of the fruits using raspberry pi. Then, the image is transmitted to the processing stage where it can extract the fruits features like shape, size and color. These processes are done using the image processing. It helps to identify and compare the fruit shape, size and color with the trained datasets. This is done during the training and testing stage. A diversity of methods for automatic separation of fruits is developed. Artificial Neural Network is the one that helps to segregate the fruits based on the quality such as good, moderate and rotten fruit. This system is capable of separating the fruits into good, moderate and rotten one with accuracy of 94.12%.

Yogesh, Ashwani Kumar Dubey, Rajeev Ratan et. al., [9] describes Automatic Detection and Classification of Nutrients Deficiency in Fruit Based on Automated Machine Learning. Automated Machine learning simplifies the task involved in deep learning application.The outcome is the prediction of the fruit surface defect in terms of probability due to nutrient deficiency.

AKNS Aishwarya Chandini; Uma Maheswari B et. al., [10] describes Improved Quality Detection Technique for Fruits Using GLCM and MultiClass SVM. A reliable mechanism is described for detecting the defects in fruits. The principal goal of this work is to detect and segregate low and best quality fruits. It is achieved using the combination of hardware and image processing techniques and machine learning algorithms. The novelty in this work is interfacing Raspberry Pi with MATLAB and image is captured. The segmentation, feature extraction, and classification is done using MATLAB. This system exhibits better performance than the existing system.

Horea Muresan, Mihai Oltean et. al., [11] presents Fruit recognition from images using deep Learning. In this approach, a new, high-quality, dataset of images containing fruits is creted. They also present the results of some numerical experiment for training a neural network to detect fruits. Some numerical experiments are done by using TensorFlow library in order to classify the images according to their content.

III. A NOVEL IMAGE PROCESSING BASED FRUIT QUALITY DETECTION SYSTEM

In this section, a novel image processing based fruit quality detection system using deep learning is presented. Determining the disease occurred to fruits and vegetables. The kind of infections they are, such as fungal, bacterial and viral. Analyzing the severity of the disease and its impact and classifying the fruits into specific quality level. They are mainly three levels poor, average and good quality fruit covering all the major fruits cultivated in India. Humans use the fruits majorly in their daily routine. The main aim is to determine the causes of having the poor quality fruits and warnings will be generated according to the

Quality. The block diagram of presented system is shown in Fig. 1.

The Fruit snapshots are captured at a resolution of 320×258×3 pixels by using High definition web camera. From experimental view, they are reduced to 150×150×3 resolution sample in the system. The dataset comprising of 12 different categories with four different fruit with each fruit divided into ripped, unripe and over ripped. All images are saved at 16 bits per channel in RGB color-space. These properties increased the dataset irregularity and show more practical scenario. The Images had huge differences in quality and radiance. Illumination is part of these variations in imagery.

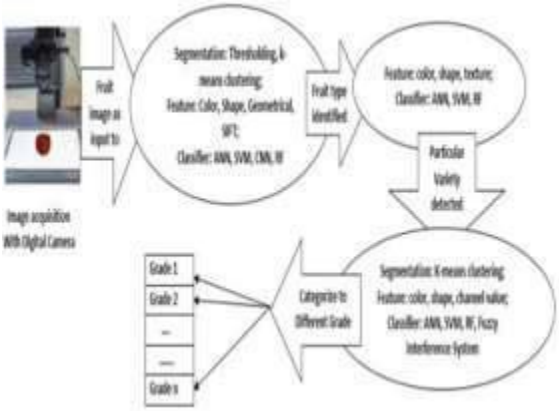


Fig. 1: Block diagram of Presented System

As a matter of fact, same fruit can generate two images due to radiance less close than two images of fruits of different. The dataset of fruits are collected under comparatively less restricted conditions. Images were also taken with different conditions i.e. with lights of the room on and off, changing the position of camera into different angle, open windows, closed windows, open curtains, and closed curtains scenario. For a real application, it is very essential to manage with radiance variation, camera snapshot artifacts, shadows and specular reflections.

After the collection of images, preprocessing is performed. Image pre-processing is required in color and shape detection process in order to perform some operations such as image conversion, compression and detection of an image. This step is important to recognize the fruits based on the color and shape of the fruit without external features like noise and background of the image. The purpose of image processing technique is to improve the quality or to extract some useful information of an image before applying color and shape detection process. The output of the processed image can help in manipulation of the digital image for the further system uses.

In the pre-processing step, the images are first normalized through normalization for reducing the data loss of the images, and then the images are introduced to data augmentation for diversifying and increasing the dataset size when the classifier is trained. After the preprocessing, the features like color, shape, size, texture, etc., are extracted from the images.

For acquiring features like texture, shape and color feature extraction is done which will reduce the resources only to the desired large set of data. For the work, a GLCM feature extraction is used. To implement the GLCM technique, the diseased area is converted from RGB to grayscale and thereafter, features are extracted. GLCM features such as contrast, energy, correlation and homogeneity are used.

Diagonal elements in contrast represent the pairs of pixels with no grey-level difference. If probabilities are high then there will be no much contrast. Energy measures the uniformity of texture in an image. The value of energy will be at its peak when the distribution of gray level is either in the form of a constant or a periodic form. Energy feature has a lesser value for small entries and inverse of it when there are large values for few entries.

Correlation calculates how each pixel is correlated to all its neighbors when an whole image is taken into account. The range of correlation is either -1 or 1 and NaN for an image which is positively correlated or negatively correlated and for a constant image respectively. Homogeneity measures closeness of the distribution of elements in the GLCM to the GLCM diagonal. Value of homogeneity ranges from 0 to 1. And considering a GLCM diagonal then the value is 1.

The extracted features are used to train the classifier. Before training, data transformation is required due to possibility of any missing features. Once the data transformation is completed next step is the selection of features from the training datasets that are needed for the training of the model. The missing data in training datasets are replaced with the mean value. The datasets are split in two parts: one for the training purpose and second for the validation. For training purpose 70% datasets are utilized and remaining 30% used for the validation of the model. This system uses Convolutional Neural Networks (CNN), a deep learning algorithm, which consists of a class of neural networks as a classifier for image recognition by a specialized way of processing on the grid of pixels.

CNN are a specialized type of ANNs used for image analysis. Since computers sees image as a matrix of numbers that represent single pixel, it is important that the relation between the pixels (values) remains same after the image is handled through the network. Convolution neural networks are used to save the spatial relationship between the pixels,that have different mathematical operations piled on top of each other to generate layers of the network.

This process trains the system for classifying and grading. For the training phase, the images of the dataset consist of fresh and stale classes of every fruit. Convolutional Neural Network (CNN) is employed to recognize the size, shape and color of different fruit samples. Thereby fruit quality is determined.

IV. RESULT ANALYSIS

In this section, A novel image processing based fruit quality detection system using deep learning is implemented using python. The result analysis of presented system is discussed here. The Fig. 2 shows the output 1.

Fig. 2: Output 1

The Fig. 3 shows the output 2 of presented approach.

Fig. 3: Output 2

The Fig. 4 shows the detection of orange fruit quality.

Fig. 4: detection of orange fruit quality

The Fig. 5 shows the detection results.

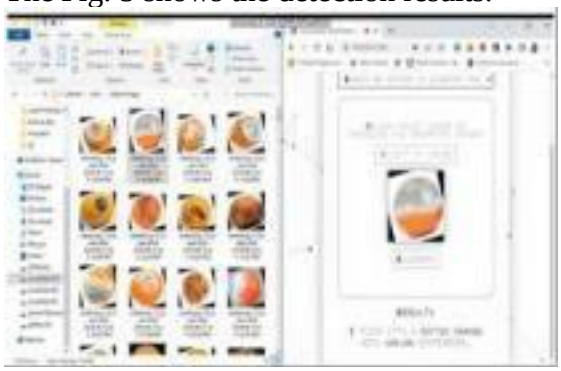


Fig. 5: Detection Results

The Fig. 6 shows the detection results of banana.

Fig. 6: Detection Results

Hence, this approach has recognized different fruits and grades the fruit quality.

V. CONCLUSION

In this work, A novel image processing based fruit quality detection system using deep learning is presented. Initially, fruit image is captured and preprocessed. From the pre-processed image, features have been extracted based on the energy, contrast, correlation and homogeneity parameters. The applied CNN method is a very powerful method for deep learning approaches that successfully recognizes the fruits of images for the presented model and the applied algorithm of CNN is successfully performed for image classification and object detection. Based on these extracted features, CNN recognizes the fruit and determines fruit quality. This approach has effectively detected different types of fruits and their quality is also determined. This system can be installed in a robot for checking the quality of the fruits and vegetables in the markets. This application system can be used as an information system between customers and shops such as markets, where the products can be graded and uploaded to the database from where the customer can get the required product within the shortest time.

VI. ACKNOWLEDGEMENT

We thank CMR Technical Campus for supporting this paper titled “A NOVEL IMAGE PROCESSING BASED FRUIT QUALITY DETECTION SYSTEM USING DEEP LEARNING”, which provided good facilities and support to accomplish our work. Sincerely thank our Chairman, Director, Deans, Head Of the Department, Department Of Computer Science and Engineering, Guide and Teaching and Non- Teaching faculty members for giving valuable suggestions and guidance in every aspect of our work

VII. REFERENCES

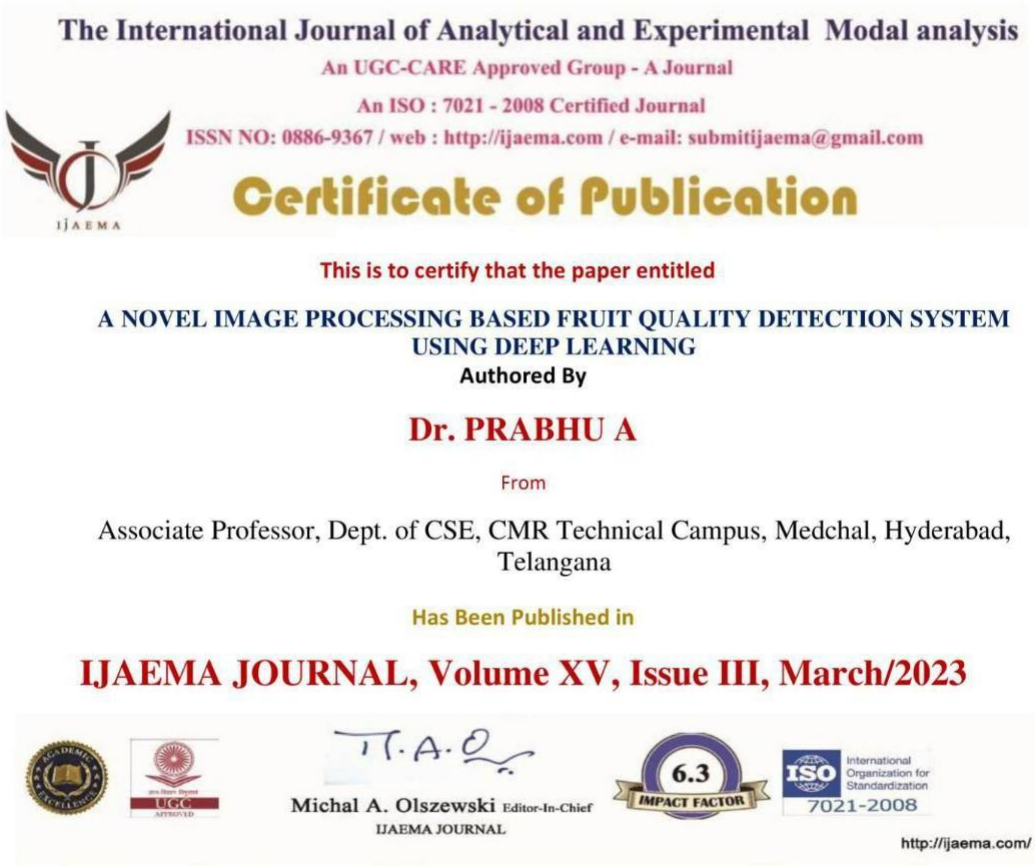
[1] Shobana G, Reethu, Sudheksha S, Vinothini K, “Fruit Freshness Detecting System Using Deep Learning and Raspberry PI”, 2022 International Conference on Innovative Computing, Intelligent Communication and Smart Electrical Systems (ICSES), DOI: 10.1109/ICSES55317.2022.9914056

[2] Keerthana S N, Predicting the Quality of Fruit using Machine Learning”, International Journal of Advanced Research in Science, Communication and Technology (IJARSCT) Volume 2, Issue

1, July 2022, DOI: 10.48175/IJARSCT-5647
[3] Tsega Y. Melessea, Matteo Bollob , Valentina Di Pasqualea , Francesco Centrob , Stefano Riemmaa, "Machine Learning-BasedDigitalTwinfor Monitoring Fruit Quality Evolution", 3rd International Conference on Industry 4.0 and Smart Manufacturing, doi: 10.1016/j.procs.2022.01.200
[4] GaneshanMudaliar,Rashmi Priyadarshini B.K, "A Machine Learning Approach For Predicting Fruit Freshness Classification", International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 08 Issue: 05, May 2021
[5] Wan Nurul Suraya Wan Nazulan,Ani Liza Asnawi, Huda Adibah Mohd Ramli, A.Z.Jusoh, S.Noorjannah Ibrahim, N.F.M.Azmin, "Detection of Sweetness Level for Fruits (Watermelon) With Machine Learning", 2020 IEEE Conference on Big Data and Analytics (ICBDA),DOI: 10.1109/ICBDA50157.2020.9289712
[6] K B Mirra, P Pooja, S Ranchani, R Rajakumari, "Fruit Quality Analysis using Image Processing", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958 (Online), Volume-9 Issue-5, June 2020
[7] Mohammed Faisal, Fahad Albogamy, Hebah Elgibreen, Mohammed Algabri, And Fattoh Abdu Alqershi, "Deep Learning and Computer Vision for Estimating Date Fruits Type, Maturity Level, and Weight", IEEE Access (Volume: 8), 2020, DOI: 10.1109/ACCESS.2020.3037948
[8] S. Krishna Kumar, J. Kaviya, G. Dilip Prakash, K. Srinivasan, "Fruit quality detection using machine vision techniques", International Journal of Advance Research, Ideas and Innovations in Technology, Volume 6, Issue 2), 2020, ISSN: 2454-132X
[9] Yogesh, Ashwani Kumar Dubey, Rajeev Ratan, "Automatic Detection and Classification of Nutrients Deficiency in Fruit Based on Automated Machine Learning", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249-8958 (Online), Volume-9 Issue-1, October, 2019
[10] AKNS Aishwarya Chandini; Uma Maheswari B, "Improved Quality Detection Technique for Fruits Using GLCM and MultiClass SVM", 2018 International Conference on Advances in Computing,Communicationsand Informatics (ICACCI), DOI: 10.1109/ICACCI.2018.8554876
[11] Horea Mures¸anMihai Oltean, "Fruit recognition from images using deep Learning", Acta Univ. Sapientiae, Informatica, 10, 1 (2018) 26–42

10.CERTIFICATES

10.CERTIFICATES



The International Journal of Analytical and Experimental Modal analysis

An UGC-CARE Approved Group - A Journal

An ISO : 7021 - 2008 Certified Journal

ISSN NO: 0886-9367 / web : http://ijaema.com / e-mail: submitijaema@gmail.com

Certificate of Publication

This is to certify that the paper entitled

A NOVEL IMAGE PROCESSING BASED FRUIT QUALITY DETECTION SYSTEM USING DEEP LEARNING

Authored By

Dr. PRABHU A

From

Associate Professor, Dept. of CSE, CMR Technical Campus, Medchal, Hyderabad, Telangana

Has Been Published in

IJAEMA JOURNAL, Volume XV, Issue III, March/2023

Michal A. Olszewski Editor-In-Chief

IJAEMA JOURNAL

6.3 IMPACT FACTOR

ISO International Organization for Standardization 7021-2008

http://ijaema.com/

The International Journal of Analytical and Experimental Modal analysis
An UGC-CARE Approved Group - A Journal
An ISO : 7021 - 2008 Certified Journal
ISSN NO: 0886-9367 / web : http://ijaema.com / e-mail: submitijaema@gmail.com

Certificate of Publication

This is to certify that the paper entitled

A NOVEL IMAGE PROCESSING BASED FRUIT QUALITY DETECTION SYSTEM USING DEEP LEARNING

Authored By

MAMINDLA MARUTHI

From

B. Tech Student, Dept. of CSE, CMR Technical Campus, Medchal, Hyderabad, Telangana,India

Has Been Published in

IJAEMA JOURNAL, Volume XV, Issue III, March/2023

Michal A. Olszewski Editor-In-Chief
IJAEMA JOURNAL

6.3 IMPACT FACTOR

ISO International Organization for Standardization 7021-2008

http://ijaema.com/

The International Journal of Analytical and Experimental Modal analysis
An UGC-CARE Approved Group - A Journal
An ISO : 7021 - 2008 Certified Journal
ISSN NO: 0886-9367 / web : http://ijaema.com / e-mail: submitijaema@gmail.com

Certificate of Publication

This is to certify that the paper entitled

A NOVEL IMAGE PROCESSING BASED FRUIT QUALITY DETECTION SYSTEM USING DEEP LEARNING

Authored By

NANJALA SAMPATH KUMAR

From

B. Tech Student, Dept. of CSE, CMR Technical Campus, Medchal, Hyderabad, Telangana,India

Has Been Published in

IJAEMA JOURNAL, Volume XV, Issue III, March/2023

Michal A. Olszewski Editor-In-Chief
IJAEMA JOURNAL

6.3 IMPACT FACTOR

ISO International Organization for Standardization 7021-2008

http://ijaema.com/

The International Journal of Analytical and Experimental Modal analysis
An UGC-CARE Approved Group - A Journal
An ISO : 7021 - 2008 Certified Journal
ISSN NO: 0886-9367 / web : http://ijaema.com / e-mail: submitijaema@gmail.com

Certificate of Publication

This is to certify that the paper entitled

A NOVEL IMAGE PROCESSING BASED FRUIT QUALITY DETECTION SYSTEM USING DEEP LEARNING

Authored By

SEGGAM AKHILA

From

B. Tech Student, Dept. of CSE, CMR Technical Campus, Medchal, Hyderabad, Telangana,India

Has Been Published in

IJAEMA JOURNAL, Volume XV, Issue III, March/2023

Michal A. Olszewski Editor-In-Chief
IJAEMA JOURNAL

6.3 IMPACT FACTOR

ISO 7021-2008 International Organization for Standardization

http://ijaema.com/