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An Automated System for Fruit Adulteration and Fruit Grading

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Abstract: This research covers deep learning approaches, a supervised machine learning model for fruit illness diagnosis, and a convolutional neural network-based fruit grading system. We employed a Visual Geometry Group (VGG) which is a part of the Convolutional Neural Network (CNN) and it produced an accurate result. Fruit disease detection is a tough task for a manual inspection system, so we have designed a system that detects the fruit disease and grades it. In recent times the machines are incorporated with a high-speed computing hardware device that allows the developers to develop the complex system using different types of machine learning models, and algorithms for better results and near accuracy. Using these advanced models of neural networks, a good model is built for classifying the better fruit. The dataset is taken from kaggle.com, and various sorts of fruit photos were utilized to train and test the model, resulting in an accurate result.
Key Terms: Supervised machine learning model, Convolutional Neural Network, Visual Geometry Group, Pre-Processing, Feature Extraction, Classification, Gray Scale Conversion, Noise Removal, Thresholding, and Image Sharpening.

I. INTRODUCTION

Any fruit substance consumed is intended to provide nourishment. Because the fruit goes through several stages of production, processing, and distribution, the nourishment in the fruit is compromised.

Adulteration is widely used to improve the texture, storage, and appearance of the fruits. Adulterants in the fruit could be a foreign or inferior chemical substance. This requires a great deal of decision-making and experience in determining when the best time is to send a specific fruit into the market for maximum profit.

While it takes a lot of manpower to segregate the fruits before sending them out to be sold in the market, it also takes a lot of time. As a result, the agricultural industry suffers from the inability to obtain fruit at the appropriate time of year.

We used a supervised machine learning model to solve one small set of problems related to fruit classification and segregation. Image recognition techniques can be used effectively to perform such repetitive and labor-intensive tasks.

II. LITERATURE SURVEY

The supervised machine learning model and convolutional neural network proposed in this system detect the presence of the adulteration in the fruit and can also grade the fruit, largely replacing the manual inspection system.

P. Kanjana Devi, Rathnamani. [1] proposed K-Means clustering algorithm for image segmentation for fruit disease detection image processing According to their methodology, clustering and fruit image segmentation algorithms are used to identify fruit diseases. To demonstrate its significance, an algorithm plot is examined using various estimations.

The project's flaw is that only the K-Means algorithm is used to detect fruit disease based on the dataset values, and the results are not very accurate.

Anand Singh Jalal, Shiv Ram Dubey. [2] proposed Using complete local binary patterns, detection, and classification of apple fruit disease their methodology focuses primarily on apple fruit diseases. Firstly, the system receives the input image which is then transformed into image pre-processing. Color global histogram, local binary pattern, color coherence vector, and completed local binary pattern are the features used for identifying fruit diseases. The project's flaw is that it only works on apple fruit and the accuracy level is unsatisfactory.

M. Nikitha, S. Roopa Sri, B. Uma Maheshwari according to their methodology the fruit is graded based on the percentage of infection. The system was created using the TensorFlow platform. Only specific fruits, such as bananas, apples, and cherries are being considered for their project and their system only grades the fruit which makes its flaw.

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III. PROPOSED SYSTEM

This section explains the proposed method for distinguishing between diseased fruits and healthy fruits. The proposed method is developed using a supervised machine learning model which categorizes each image into a healthy one and a diseased one and also, and we've used a convolutional neural network as our basic model.

Here we used VGG (Visual Geometry Group) for the analysis of the data set because VGG is proven to perform in ImageNet challenges.

VGG's convolutional neural network model has 16 convolving layers. In our project, we have checked the most optimal number of convolving layers, because of issues with erasing, exploding gradients, and underfitting or overfitting (this causes because of lack of large training and testing dataset).

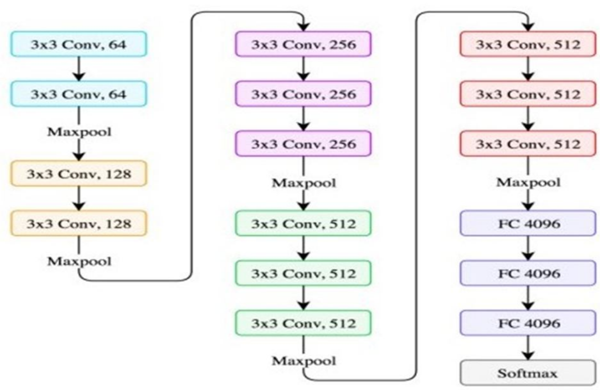


Figure 3. VGG16 Model

1) Implementation of VGG

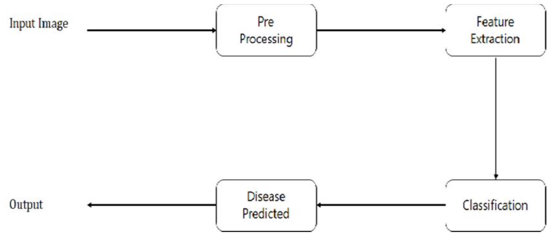
```
from os import makedirs
from os import listdir
from shutil import copyfile
from random import seed
from random import random

#create directories
dataset_home = '/content/drive/My Drive/MajorProject/fruits/'
subdirs = ['train/', 'test/']
for subdir in subdirs:
  #create label subdirectories
  labeldirs = ['healthy/', 'dis/']
  for labldir in labeldirs:
    newdir = dataset_home + subdir + labldir
    makedirs(newdir, exist_ok=True)
#seed random number generator
seed(1)
#define  ratio of pictures to use for validation
val_ratio = 0.10
#copy training dataset images into subdirectories
src_directory = '/content/drive/My Drive/MajorProject/Fruits/train/'
for file in listdir(src_directory):
  src = src_directory  + file
  dst_dir = 'train/'
  if random() < val_ratio:
    dst_dir = 'test/'
  if file.startswith('healthy'):
    dst = dataset_home + dst_dir + 'healthy/' + file
    copyfile(src, dst)
  elif file.startswith('dis'):
    dst = dataset_home + dst_dir + 'dis/' + file
    copyfile(src, dst)
```

Figure 6. Creating appropriate directories to give input to the model

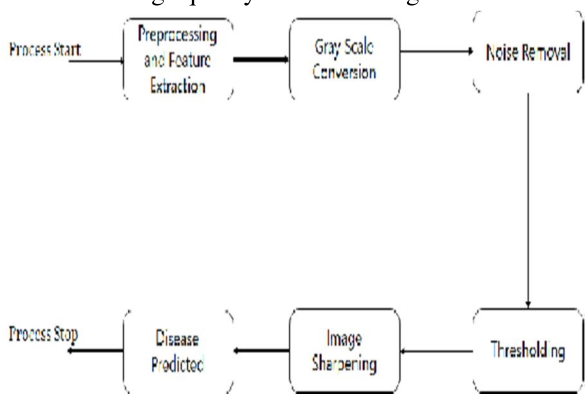
IV. SYSTEM ARCHITECTURE

The system architecture briefly discusses how the system works. In the first step, the fruit image is fed to the system, in the second step, image pre-processing is done. Pre-processing is used to change the raw data into a clean dataset and also the image is prepared for further analysis. In the third stage, the image's characteristics are extracted where raw data is transformed into numerical features that can be processed while keeping the original dataset. In the fourth step, image classification is done where the image is identified and grouped into pre-determined categories. In the fifth step, if there is any disease predicted from the given image then the disease name is shown in the GUI and also remedies will be shared. The below figure depicts the architecture of the system.

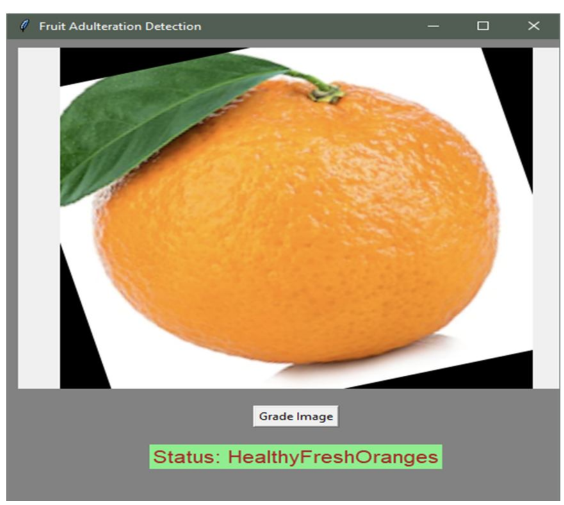


V. ARCHITECTURE OF SUB-SYSTEMS

The architecture of subsystems explains the inner depth working of the system architecture. In system architecture, Pre-processing and Feature extraction is considered important step. In these steps-initial grayscale conversion, the method is used to get desired grayscale image which helps in simplification of system work and also reduces code complexity, then the noise is removed from the image (noise in the image can be a random variation of brightness), then the image is broken into several segments for better image analyzing, then the image is sharpened to reduce the blurriness which was introduced by the camera, it also draws attention to the egdes of the fruit in the image and also increases image quality. The below figure shows the sub-system architecture.

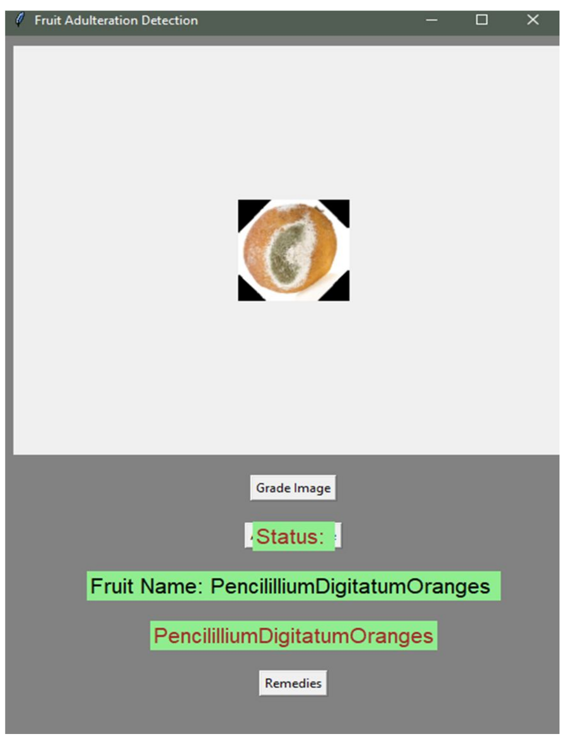


VI. SNAPSHOTS




Fruit Adulteration Detection
Grade Image
Status:
Fruit Name: BrownRotApple


Fruit Adulteration Detection
The remedies for BrownRot are:
Thiophanate-Methyl spray,Organic Spray,Captan sanitizing spray
Exit


Fruit Adulteration Detection
Grade Image
Status:
Fruit Name: PencililliumDigitatumOranges
PencililliumDigitatumOranges
Remedies

VII. ADVANTAGES

1) Replaces the manual inspection system.
2) Gives accurate results when compared to a manual inspection system since the system is trained using a supervised machine learning model.
3) Cost maintenance of the system is affordable and easy to use.
4) The system has a user-friendly interface which makes it easy for the buyer to use the system and get accurate results.
5) The proposed system also helps in time-saving during fruit inspection when compared to the manual inspection system.

VIII. CONCLUSION

A. This will enable the technology to replace the manual inspection system of the fruit. The computer vision-based system is authentic, equitable, and non-destructive.
B. Computer vision is done for sorting and grading the fruits based on external and internal factors. The variation in the image quality affects the system.
C. In short, this system is designed to check whether the fruits are edible to eat or not, and also it satisfies the consumers who spend their money on buying the fruit.

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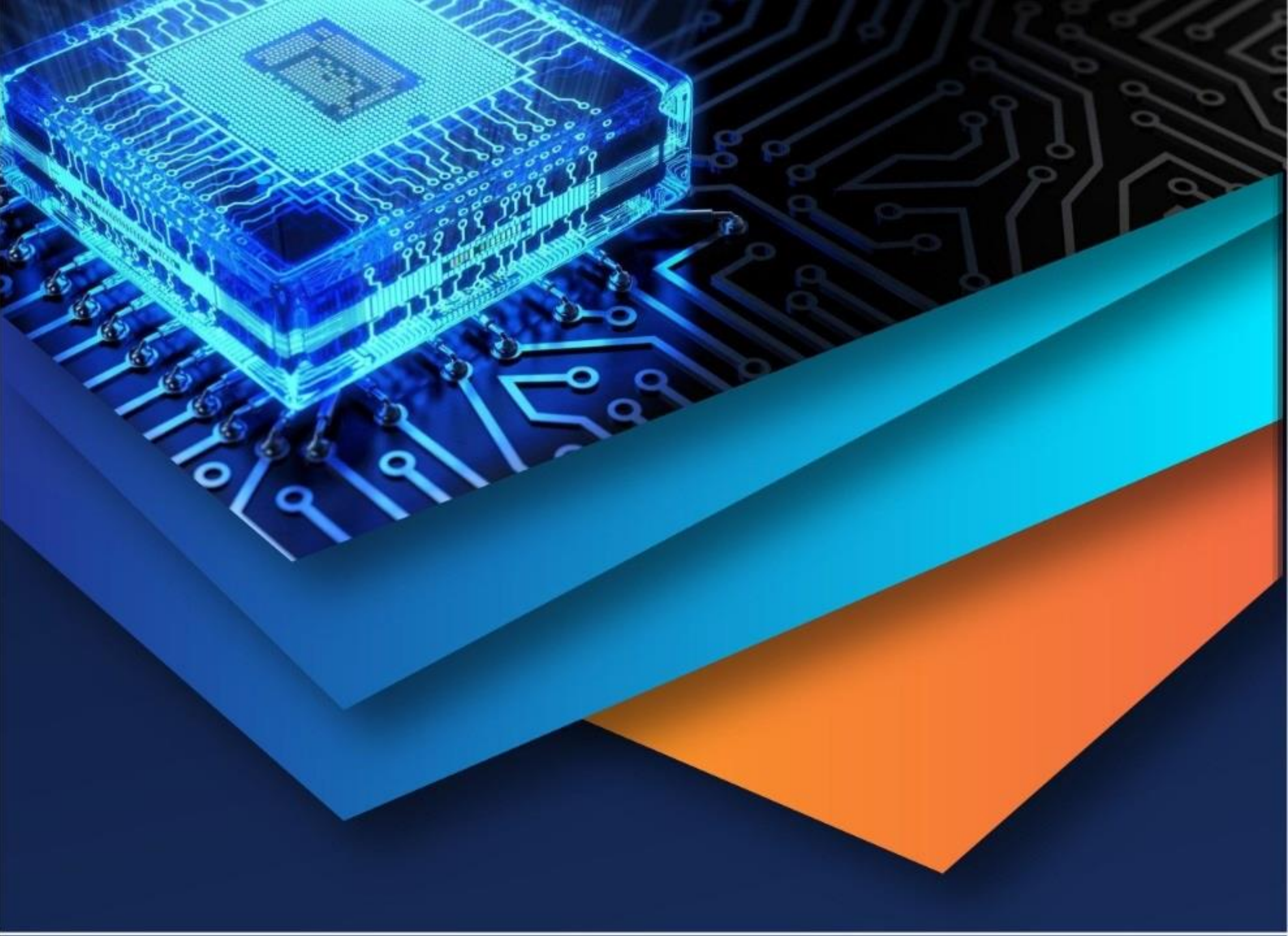

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