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# A Comparative Analysis of Fruit Disease Detection Using Deep Learning

**Suman S [1*], Adarsh MJ [2]**

[1]Student, [2]Assistant Professor, Department of Computer Application
JNN College of Engineering Shivamogga

suman.suresh587@gmail.com, adarshmj@jnnce.ac.in

***Abstract***

*Agriculture occupies a central role in the Indian economy and acts as the main source of livelihood for a substantial segment of the population worldwide. Therefore, enhancing fruit production is crucial. The health and quality of fruits are often undermined by diseases, primarily caused by bacterial and fungal pathogens. Early detection of fruit diseases is beneficial for agricultural practitioners as it reduces expenses by enabling the forecasting and averting of disease outbreaks. Identifying the most fruitful techniques for the detection of fruit diseases is a proactive measure to mitigate the impact of these diseases in their initial stages. To protect farmers' investments experts are devising a method to detect infections in fruits the main goal of their study is to assess various deep-learning techniques for identifying fruit diseases the paper presents an innovative approach that combines deep learning with machine learning for detecting and classifying fruit diseases it employs multiple feature extraction and selection techniques utilizing a comprehensive fruit dataset to test both machine learning and deep learning classifiers the proposed hybrid CNN model demonstrated a remarkable 97.10 accuracy in extensive experimental tests across all fruit image datasets.*

***Keywords:*** Fruit Disease Detection, Feature extraction, Deep-Learning Techniques, Classification.

## 1. Introduction

The advancement of machine learning and computer vision has revolutionized agricultural technology, changing the way we categorize fruits and assess their quality. This paper conducts a comprehensive study on deploying these cutting-edge technologies for fruit classification. We introduce a robust machine learning framework employing Convolutional Neural Networks (CNNs) to identify and distinguish various fruit types, ranging from common fruits like bananas and apples to exotic ones like dragon fruit and lychee. Our method compiles a broad and varied dataset encompassing many fruit characteristics, including size, color, texture, and shape. This dataset is the foundation for tutoring our Convolutional Neural Network (CNN) models, enabling them to learn and deliver highly precise predictions. The paper delves into the challenges of multi-class fruit classification, addressing issues such as handling unbalanced datasets and ensuring the model's generalizability across various fruit types. The introduction sets the stage for an in-depth analysis of our data-centric approach, which seeks to improve the effectiveness of fruit sorting processes and reduce food waste. Through machine learning, we aim to illuminate the complexities of fruit classification and pave the way for smarter, eco- friendly agricultural practices.

## 2. Literature Survey

The analysis by the authors, Anand and Shiv Dubey [1], examines diseases such as Apple Smear, Apple Rot, and Apple Scab. In the early stage, the input image goes under preprocessing, including conversion from RGB to L*a*b* color space. The identification of fruit diseases utilizes features like Global Color Histogram, Local Binary Pattern, Color Coherence Vector, and Textured Neighborhood Binary Pattern.

M. Nikhitha, S. Roopa Sri et al., [2] developed on the TensorFlow platform and conheswari propose a scheme that also grades fruits siders bananas, apples, and cherries for the probased on the level of disease. This scheme is posed work.

P. Kanjana Devi, Rathamani [3] Recently, clustering and fruit image segmentation algorithms have been implemented to identify fruit diseases. To demonstrate their importance, the algorithm's framework is evaluated using various assessments.

Kawaljit Kaur, Chetan Marwaha [4] This work investigates diseases resulting from fruit harvesting. Image processing methods are employed to evaluate the deterioration of fruit crops. A brief analysis of filtering techniques associated with distortion detection is presented.

The study by Uday Pratap Singh and Siddharth Singh Chouhan [5] focuses on utilizing a convolutional neural network (CNN) to classify Anthracnose disease-infected leaflets of mango. The CNN methodology consists of six convolutional layers, including ReLU activation and three maximum pooling layers, two layers with high density, and an outcome layer that utilizes the SoftMax function. The model is taught with the reverse propagation algorithm.

Wenyan Pan1, Jiaohua Qin [6] In this study, the authors attempt to compile a picture dataset of various citrus illnesses. The datasets in this research include six distinct categories of diseases, which are detected utilizing an automated screening technique founded on densely linked convolutional neural networks.

Xi Cheng, Youhua Zhang [7] In this review, an infestation identification strategy is initiated that utilizes the usage of deep learning to achieve pest awareness with the agricultural farmland background. In contrast to support vector models and neural networks, bug image identification using this method is rapidly improved in agricultural farmland.

Brahimi, Kamel [8] In the present article, investigators used deep learning, and the findings reveal that deep models and CNNs function in the order of cherry illnesses. The objective is to minimize the level of detail and dimensions of complex models. Further, element representation is a fascinating field in deep learning as well, and it may be used to detect plant illnesses.

## 3.Proposed Methodology

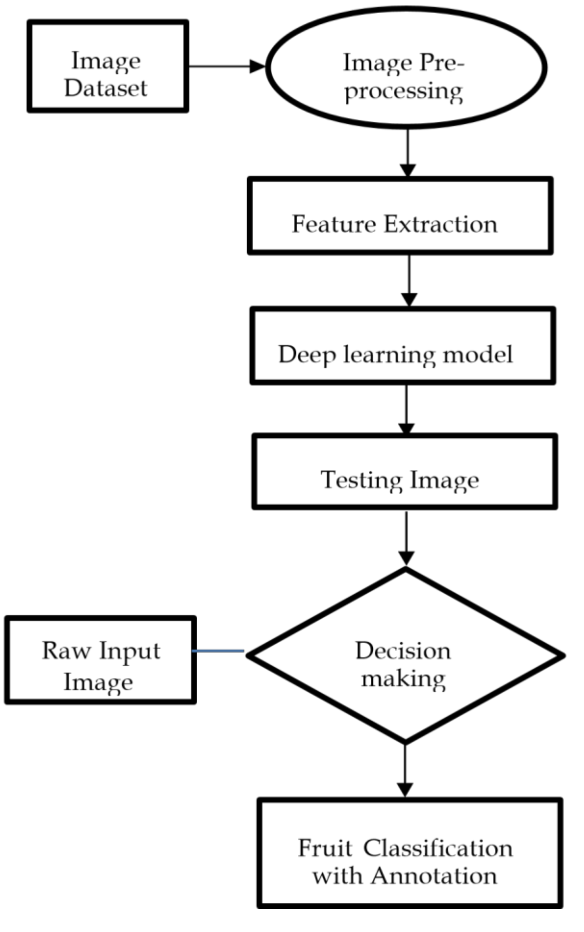


Fig 3.1: Fruit Disease Detection Flowchart

### 3.1 Image dataset

Begin by gathering a vast collection of images depicting healthy and diseased fruit crops. These should encompass different growth stages, varieties, and various disease types and severities.

### 3.2 Image Pre-processing

Correctly preparing images of fruit can improve disease classification, which permits prompt action and reduces the danger of crop damage. This involves enhancing features specific to the disease and eliminating irrelevant noise.

### 3.3 Feature Extraction

Feature derivation includes finding relevant characteristics from fruit images. These features can include color histograms, texture patterns, or shape descriptors.

### 3.4 Deep learning model and testing image

Deep learning models such as Convolutional Neural Networks (CNNs) are trained on labeled fruit pictures to classify diseases. These models learn characteristics from the images and can accurately classify diseases.

### 3.5 Decision making

Decision-making involves deep learning models to classify disease types, predict disease severity, and guide appropriate management strategies.

### 3.6 Fruit Classification with Annotation

Fruit classification involves categorizing fruits based on their characteristics. An annotated classification includes labels or descriptions assigned to each fruit type, aiding in accurate identification and management.

## 4. Results & Discussions

This work focuses on developing a systematic method for identifying the Fruit Disease Detection with the help of different fruit pictures as the dataset. YOLOv8 algorithm detects the diseases present in the fruits by single pass detection, bounding box prediction, class prediction, Non-maximum suppression, training, and finetuning.

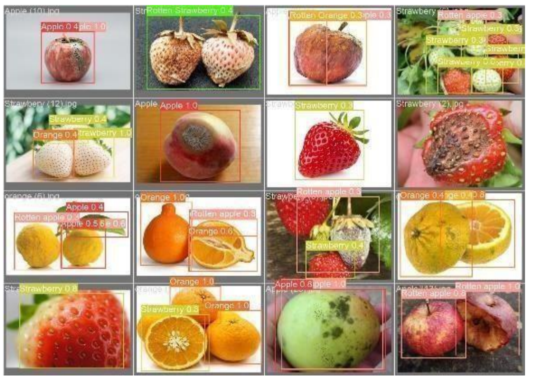

Fig 4.1: Annotated fruits with classification and Disease Identification

Fig 4.2: Annotated fruits with classification and Disease Identification

Figures 4.1 & 4.2 illustrate the fruit images identifying correct fruits with annotating levels and identifying diseases displayed in the particular fruit.

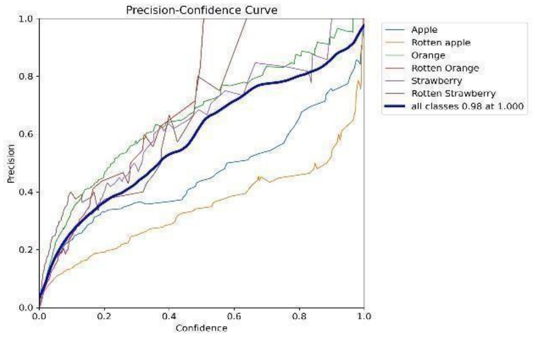


Fig 4: Precision-Confidence Curve

The above picture shows the relationship between confidence in positive disease predictions and their accuracy. Commonly, an increase in confidence along with improved precision, results in fewer false positives of confidence.

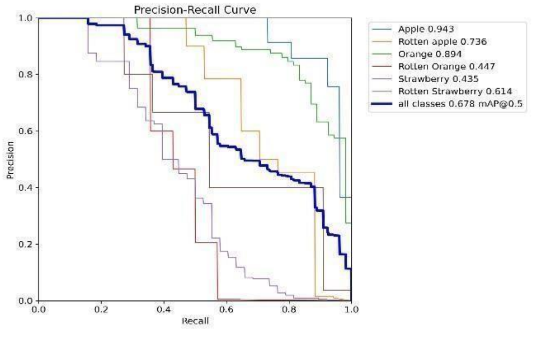


Fig 5: Precision-Recall Curve

A precision-recall curve shows the trade-off between the accuracy of positive disease predictions and recall (ability to identify all true positive cases). It helps evaluate the model's performance, where a higher area under the curve indicates better overall accuracy in detecting diseased fruits.

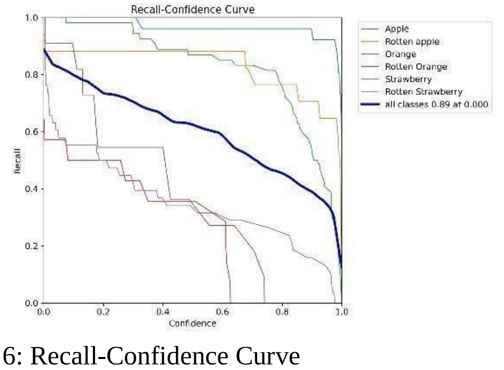


Fig 6: Recall-Confidence Curve

A recall-confidence curve in fruit disease detection depicts the connection among the recall rate (ability to identify all true positive cases) and the confidence level of the predictions. As confidence increases, recall typically decreases, indicating fewer true positives are identified at higher certainty levels.

## 5. Conclusion

The implementation of the YOLO algorithm in detecting fruit diseases through deep learning has shown amazing effectiveness. It provides real-time detection with impressive accuracy. YOLO's capability to concurrently recognize various diseases and swiftly process images renders it ideal for agricultural practices. It effectively handles the precision-recall tradeoff, ensuring a harmonious balance in identifying diseases accurately and extensively. YOLO's solid performance promises substantial improvements in disease control and agricultural productivity.

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