**RESEARCH PAPER**

# Enhanced Fruit Freshness Prediction with classification using Transfer learning and Machine learning

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**ABSTRACT**
Fruits are used for boosting immunity on human health. Fruits provide fiber, vitamins,antioxidants and minerals for human health and prevent chronic diseases. Fruit freshness is important and needs to be checked before taking fruits. Apple is one of the best fruits for human health and the rate of disease affected is decreased by taking one apple every. Defected fruits are most dangerous for the human body which creates several health disorders such as food poisoning and allergic reaction on the human body.Machine learning and transfer learning models used in proposed research to predict fruit freshness. YOLOv8 model from machine learning and Vision transfer(ViT), EfficientNetB3 from transfer learning used in proposed research to identify fruit freshness. The EfficientNetB3 transfer learning model produces best accuracy 95% which is higher than other models such as YOLOv8 and ViT including existing works.The proposed research is useful for creating awareness on fruit freshness used for human beings.

**Keywords:** YOLOv8, Fruit freshness, ViT,Machine learning,EfficientNetB3, Transfer learning
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## I. INTRODUCTION

Fruit undergoes observable changes in color, texture, and shape as it grows and ripens, and it is essential for daily nutrition. In light of these differences, fruit quality assessment is vital for lowering food waste and raising customer satisfaction. Conventional manual inspection techniques frequently lack objectivity and efficiency. Many researchers are using deep learning-powered computer vision techniques to solve this problem. By cutting waste and enhancing quality control, an automated fruit classification system not only expedites the inspection procedure but also advances sustainability. However, applying these models to other kinds of fruit can be difficult. Machine learning is artificial intelligence technique used for task prediction like health care disease detection such as mental disorders, heart diseases, liver cancer and kidney disorders. YOLO models are most commonly used for object tracking from machine learning. YOLOv8 is the more efficient than other existing works to predict task.

Because they provide vital vitamins, minerals, and fiber,

fruits and vegetables are essential to a balanced diet. From farm to table, it's crucial to keep them fresh, but poor storage conditions and lengthy transit times frequently lower quality. In addition to lowering taste and nutritional value, this puts consumers' health at risk and causes large financial losses throughout the supply chain. The need for effective systems that can precisely determine the freshness of produce before it reaches retail shelves or end users is growing as consumers become more health-conscious.

Transfer learning models are more popular due to pre trained mechanism over deep learning models.Medical field such as several human health disorders prediction results shows better than machine learning including deep learning models.Proposed research idea is used to identify fruits freshness. ViT and EfficientNetB3 transfer learning models used for fruit freshness detection including fruit classification.

The quality of a fruit or vegetable is largely determined by its freshness, which has a direct impact on consumers' physical well-being and ability to cope. It determines the fruit or vegetable's nutritional value. A systematic and accurate method for classifying and detecting freshness in fruits and vegetables is presented in this paper. The training and assessment datasets are large and varied, covering a broad range of fruits and vegetables under different circumstances. A fruit or vegetable's color, texture, shape, and size can all be used to determine its freshness. For example, fresh produce is vibrant and devoid of brown spots or mold. Conventional techniques for evaluating the quality of fruits and vegetables are laborious and prone to mistakes. Apple is one of the best fruit for human health and it helps to boost immunity by increasing nutrition's in the body. Apple freshness depends on environment conditions. Figure 1 shows real time image taken from house, listed healthy apply and unhealthy apple called rotten. Rotten apples available in market with low price but it may cause harmful to body.Eating rotten apples cause food poisoning.

**Fig 1Apple freshness**

The classification task is presented as a multiclass problem, with each class standing in for a particular produce type and the level of freshness that corresponds to it (e.g., fresh apple, spoiled banana). The model can learn fine-grained differences between various produce types and freshness thanks to this formulation.

The proposed research is to predict fruit freshness and it is identified based on certain features such as firm texture, vibrant color, mold absence and wight change due to change in moisture content presents. Fruits affected by several diseases due to water loss in filed and environment factors based on humidity as well as temperature. Transfer learning models introduced by proposed idea is better solution for fruit freshness identification

## II. LITERATURE SURVEY

Machine learning algorithms proposed by authors to identify vegetable conditions for freshness. Deep learning is another choice for fruits as well as vegetables freshness detection. Transfer learners replaces deep learning models to predict fresh and rotten fruits. Principal component analysis used for fruit freshness prediction using features called eigen values and eigen vecors [1].

Brain disorders are the mental conditions of the human health conditions predicted by deep learning models. CNN is used to identify mental health abnormalities and to classify brain disorders [2]. Signal processing is used to extract features from ECG signal and extracted features such as QRS amplitude as well as interval applied to machine learning algorithms for heart disease prediction. Super vised techniques such as ensemble methods used to identify cardiovascular conditions with enhanced accuracy over existing works [3]

Machine learning-driven computer vision systems provide an inexpensive, scalable, and non-destructive freshness detection option. These systems are able to analyze visible quality indicators directly from images, including mold, discoloration, and deterioration of surface texture. The performance of image-based food quality assessment has been greatly enhanced by recent developments in deep learning, especially in convolutional neural networks (CNNs). CNNs are excellent at capturing minute distinctions between fresh and spoiled produce because they automatically learn spatial hierarchies of features [4].

CNN accelerator is used to increase performance of CNN model. Eye disorders are the abnormalities in human eye such as diabetic eye predicted by CNN accelerator. FPGA is a device where functionality of the circuit verified as well as re configurable.Proposed research implemented on FPGA to identify ocular diseases [5]. Defects on mango

identified using deep CNN and this method shows highly accuracy in mango defects prediction over other research works [6].

The technique evaluated citrus freshness using near-infrared spectroscopy and a neural network, producing reliable results even with subtle visual cues. achieved extremely high accuracy by capturing moisture-related features using terahertz imaging and conventional machine learning classifiers. Although these multimodal systems increase generalizability, scalability issues arise because they usually call for specialized hardware [7]

Sudden cardiac arrest is identified using decision tree and support vector machine from machine learning and compared prediction accuracy results with deep learning networks such as CNN [8].NLP is used to identify cyber bullying and compared detection accuracy with CNN from the deep learning networks [9].Fruit quality predicted using CNN and results shows highly accurate than existing research ideas [10].

The goal of this project is to improve fruit rot detection's accuracy and effectiveness. It accomplishes this by using sensors to identify the gases that the fruits emit and by using machine learning models like light weight model to analyze photos in order to get a more thorough assessment of their degree of freshness. The models can accurately identify different levels of fruit freshness because they were trained on large image and sensor data datasets. The freshness of the fruits can be promptly monitored thanks to real-time data analysis and reporting to a networked technology ecosystem [11].

## III. METHODOLOGY

Fruit freshness identified by artificial methods such as machine learning.YOLOv8 is a model from machine learning to predict fruit freshness. ViT and EfficientNetB3 are the networks from deep learning used to detect fruit defect accuracy as shown in figure 2. Pre processing is the operation performed to eliminate noise, data cleaning, re sizing and normalization task. Features extracted from a fruit are color, texture, shape, and size can all be used to determine its freshness. Fresh produce is vibrant and devoid of brown spots or mold.Artificial intelligence uses extracted feature to detect freshness of the fruit.

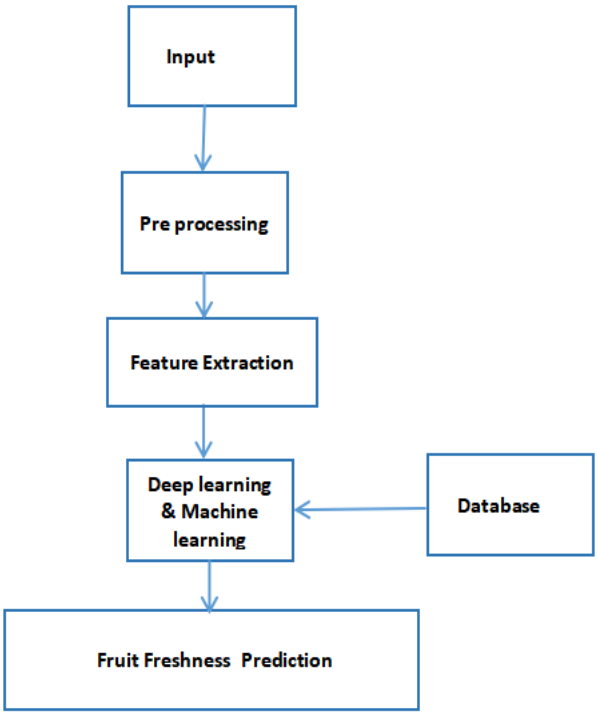


**Fig 2 Fruit Freshnes prediction model**

Figure 3 shows YOLOv8 model for identification of fruit freshness. In order to increase accuracy, backbone stages are first used to extract features from input.The next stage, known as the neck, incorporates characteristics from every stage of the backbone. Here, accuracy is increased by using c2f to map high-level features into lower-level features. The last step in the traffic density prediction process is the head.In mathematics, convolution is the process of combining two functions to produce a third. Convolution is frequently used in signal processing and computer vision to apply filters to signals or images, emphasizing particular patterns. CNNs extract features from inputs, such as images, using a method known as convolution. Convolutions are organized by paddings (p), strides (s), and kernels (K).

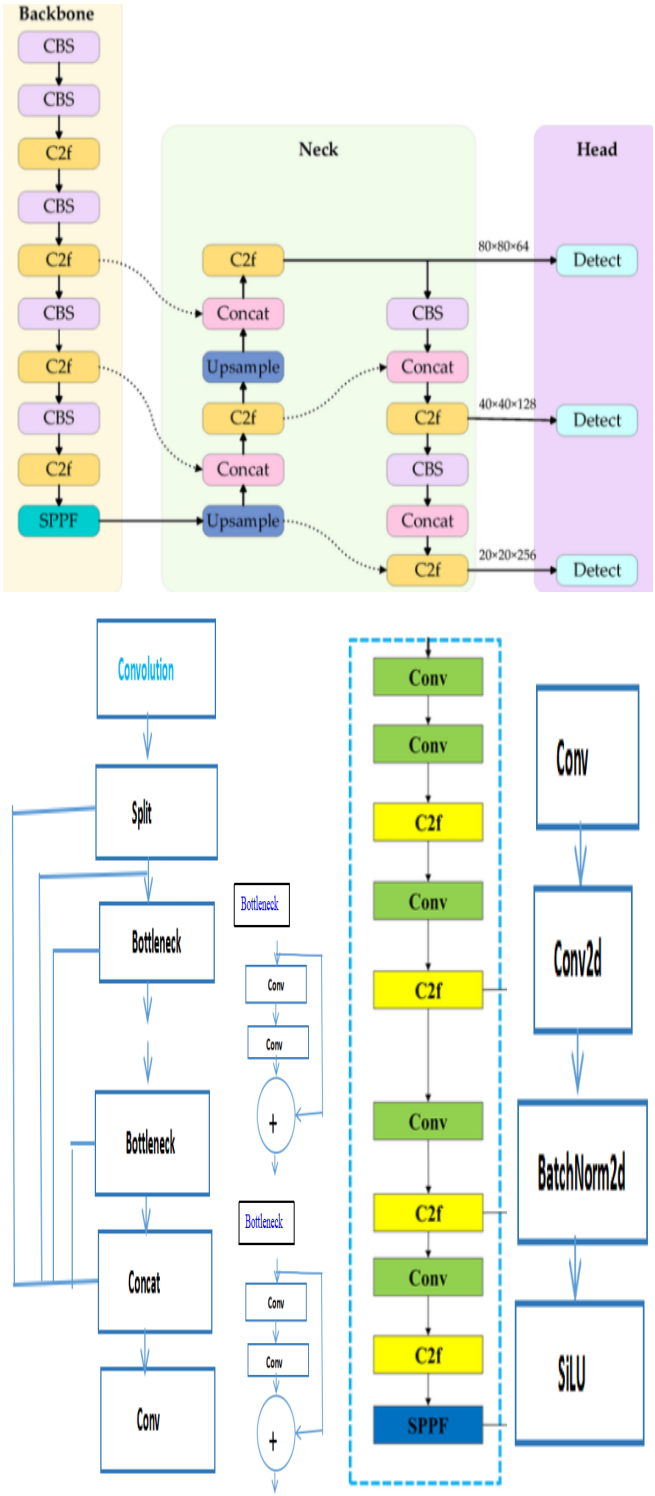


**Fig 3 YOLOv8 model fruit fresnness prediction**

Fruit freshness detected by EfficientNetB3 model as shown in figure 4. The first layer of the suggested model contains a convolution block is the 1st layer to extract features from the input. Input channels expanded by mobile inverted bottleneck convolution (MB conv) blocks.Depth and Width decresed by 7 MB blocks and also reduce spatial resolution. At last fully connected layer uses softmax function for fruit freshness identification.

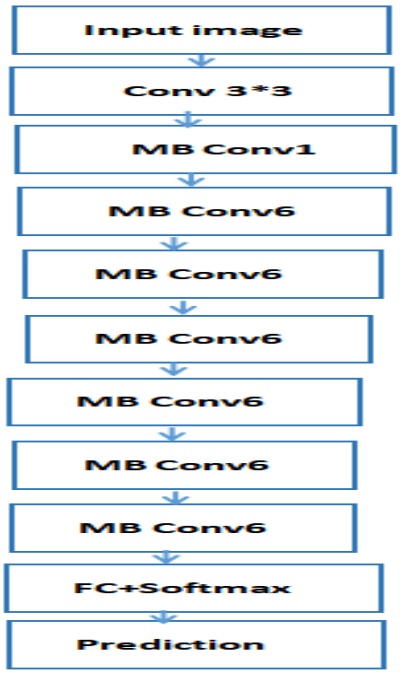


**Fig 4 EfficientNetB3 transfer learning model**

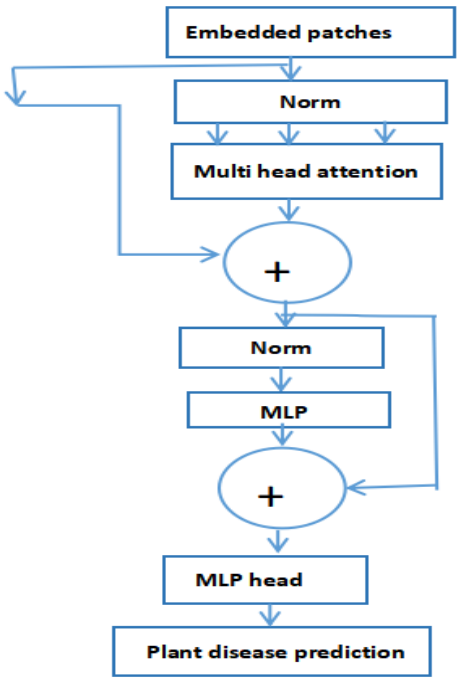


**Fig. 5 Fruit freshness prediction by ViT model**

Fruit freshness prediction by ViT transfer learning model shown in figure 5.An embedded patch converts a 2D image into a sequence of patch embedding, much like tokens in natural language processing. It generates the input for the Transformer by transforming spatial data into a linear sequence.Before the focus and feed-forward Pre-Layer Norm applies Layer Norm to multiple blocks. By doing this, gradient flow is stabilized and the exploding/vanishing gradient problem in deep transformers is prevented. Multi head allows each patch to attend to every other patch in order to capture relationships between distant image regions and model global dependencies.Fruit freshness is predicted using a soft max function and two fully connected layers in the MLP head.

## IV. RESULTS AND DISCUSSION

The proposed results described by performance metric such as accuracy obtained from three models one from machine

learning and two from transfer learning models. research method uses transfer learning. YOLOv8 from machine learning and ViT, EfficientNetB3 models from transfer learning use in proposed research for identification of fruit freshness.


**Fig. 6 Banana and apple freshness**

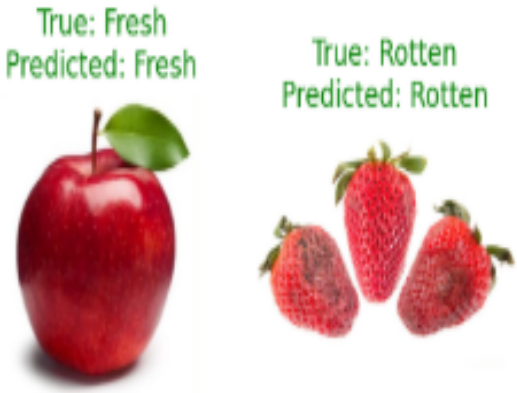


**Fig. 7 Rotten and freshness**

Banana and fruit freshness actual and predicted as fresh shown in figure 6. Rotten for strawberry and fresh for apple prediction simulated results obtained from proposed research as shown in figure 7. Figure 8 represents proposed research results of Confusion matrix obtained from EfficientNetB3 model. Prediction loss obtained from YOLOv8 as shown in figure 9.Performance metric such as accuracy of proposed research to predict fruit freshness as shown in figure 10.

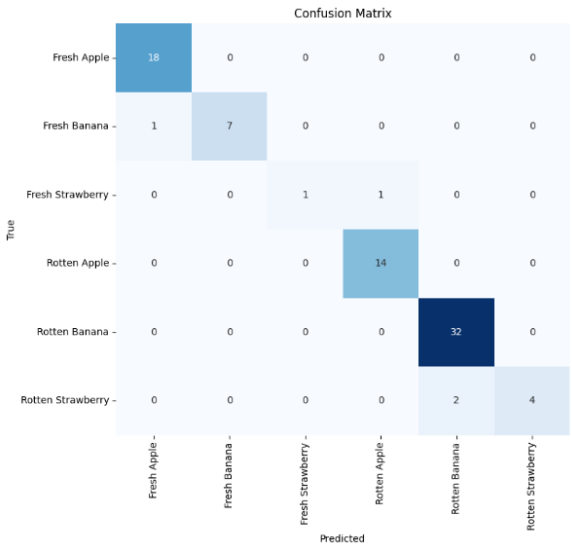


**Fig.8. Proposed research results of Confusion matrix**

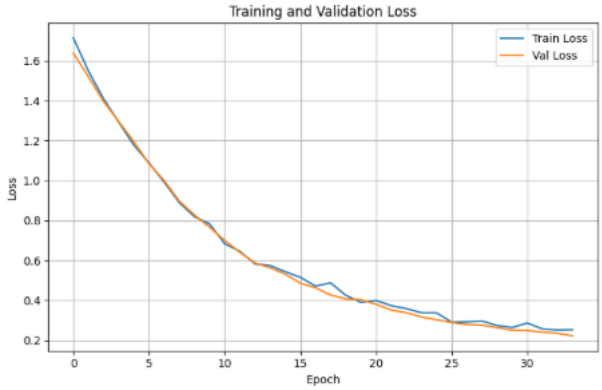


**Fig.9. Accuracy**

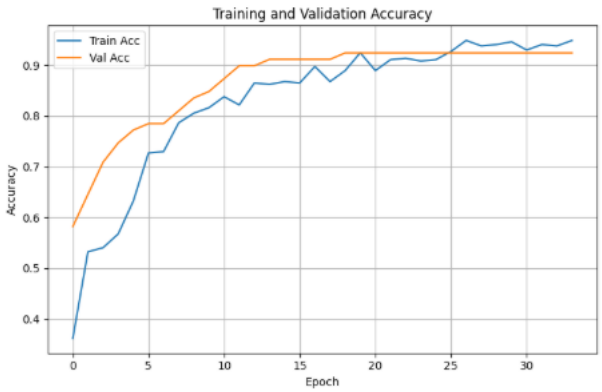


**Fig.10. Model Preiction loss**

Accuracy is one of the performance metric in artificial intelligence and proposed model accuracy listed in Table 1. EfficientNetB3 transfer learning model got 96% accuracy over other models such YOLOv8 and ViT transfer learning model. Figure 11 is Fruit freshness detection accuracy comparison and YOLOv8, EfficientNetB3 models shows more accurate than ViT models

**TABLE 1 FRUIT FRESHNESS IDENTIFICATION ACCURACY**

| S.N | Algorithm | Accuracy(%) |
|---|---|---|
| **1** | YOLOv8 | 93 |
| **2** | ViT | 91 |
| **3** | EfficientNetB3 | 95 |

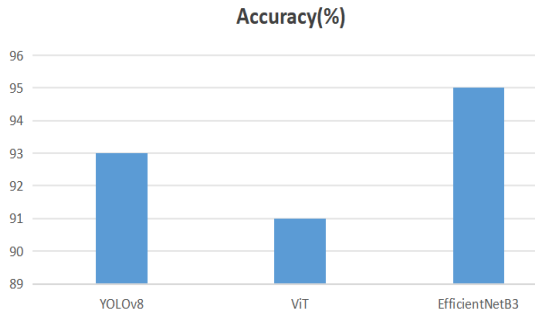


**Fig.11. Fruit freshness detection accuracy comparison**

## V. CONCLUSION

Fruits provides nutrition's and vitamins for human body and rotten fruits such defected fruits are most dangerous for human health which creates food pensioning.Proposed model uses apple, banana and strawberry for fruit freshness classification such as fresh or rotten.YOLOv8, ViT and EfficientNetB3 models used in proposed research for freshness identification. EfficientNtB3 trnasfer learning

model accuracy results 95% as high compared to YOLOv8 machine learning model. YOLOv8 model is better than other transfer learning models such ViT. This research proposes awareness and freshness prediction of three fruits such as banana, strawberry and Apple.

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