Moving object detection and tracking Using Convolutional Neural Networks

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| Santhosh K  Department of Computer Science Engineering  Sai Vidya Institute of Technology,  Bangalore, India  santhoshk.18cs@saividya.ac.in  Suhas M  Department of Computer Science Engineering  Sai Vidya Institute of Technology,  Bangalore, India  suhasm.18cs@saividya.ac.in  Tejas Manu S  Department of Computer Science Engineering  Sai Vidya Institute of Technology,  Bangalore, India  tejasmanumanus.18cs@saividya.ac.in  Vaishnavi A Kumar  Department of Computer Science Engineering  Sai Vidya Institute of Technology,  Bangalore, India  vaishnavia.18cs@saividya.ac.in | Prof. Kshama S B  Department of Computer Science Engineering  Sai Vidya Institute of Technology,  Bangalore, India  kshama.sb@saividya.ac.in |

***Abstract*— India is an agricultural country where a variety of fruits and vegetables are grown and produced for consumption as well as export. India is in the second position after China in the production of fruits. Texture, Color & freshness are the important parameters for fruit quality identification. Color recognition is a very important process in ripeness detection. The ripeness detection is an external quality factor. It is also important to check for any bacterial/fungal growth on the fruit/vegetable as due to these various factors, defective fruits can be recognized. The shelf life of fruit is also an important factor to take into consideration. Without determining the shelf-life of fruit and vegetables, there is a large amount of fruit/vegetable being wasted or rotten in the warehouse facilities and stores. Shelf-life prediction is a method that determines how long an item lasts until its “end of life”. For fresh produce, this usually means the time until an item is no longer acceptable to sell to a consumer.**

**Our goal is to develop a model where it is able to scan the fruit/vegetable in real-time and analyze it to tell if it is good or bad based on external factors such as color, freshness, texture, absence of defects and also predict the approximate shelf life of the product and display it to the user.**

**Determining the shelf life of the products will help in making a better decision on managing the fruits and storing the product that has a longer shelf life in the warehouse and transporting them to farther regions whereas products with small shelf life are shipped to local shops or sold faster thereby avoiding food wasted**

**We will be using transfer learning methodology to implement the same. This method is accurate and more efficient when compared to CNN, mainly because in CNN we will have to train the model using all variety of data set and the classification takes place based on those data sets only, whereas in transfer learning, we will be using limited data set to train our model and the model will gain knowledge as we provide the testing data set and this stored knowledge will help in achieving better accuracy and lower the training time.**

I. INTRODUCTION

According to the National, Horticulture Database India produced 99.07 million metric tonnes of fruits and 191.77 million metric tonnes of vegetables, which accounts for around 15% of the world’s vegetable production.

It's estimated that approximately 20% of produce or more gets thrown out for cosmetic reasons like weird shapes or blemishes on a peel you don't even eat. That's one in five fruits and vegetables getting tossed into landfills even though they're just as nutritious and delicious to eat. Fruits and vegetables are a vital part of the human diet to keep them healthy and free of diseases and deficiencies. Depending on their age and sex, federal guidelines recommend that adults eat at least 1½ to 2 cups per day of fruit and 2 to 3 cups per day of vegetables as part of a healthy eating pattern.

Many factors are taken into consideration during the sorting process of fruits and vegetables. These factors are internal quality factors and external quality factors. The external quality factors are texture, shape, colour, size and volume, and internal quality factors are taste, sweetness, flavour, aroma, nutrients, carbohydrates present in that fruit.

Sorting of these fruits and vegetables were being done manually by humans which required a lot of time and labour with places and chances of human error namely leaving an infected/rotting fruit with the rest of the fruits which were qualified as good, leading to the infection of the rest of the good fruits and therefore spoiling the produce. This is just one of the scenarios that can occur due to human neglect. Our model can be used to avoid such scenarios.

In this paper we will be developing a model using transfer learning and comparing its accuracy with the accuracy obtained from the model being developed using CNN. We will be using transfer learning to attain more accuracy compared to CNN. Transfer Leaning is more efficient and requires less training time as compared to CNN. For CNN you need to more preprocessing of the dataset but with transfer learning you only need to little processing of dataset like resize to 227 x 227 or 224 x224 according to selected Pre-trained Models (Alex Net, Google Net, ResNet, VGG Networks etc. and more) this saves much time of preprocessing data.

In CNN we have to provide a large variety of data set and based on those data the classification will be done and this leads to low accuracy when we introduce any test data that the model is not being trained with. Whereas in transfer learning the model will use the partially provided data set to learn and as we test the model it will gain knowledge from the test data as well and store it. This knowledge is then again used while classifying the next set of data. So this leads to reduced training time and increased accuracy as the model keeps learning.

In this paper we include another feature to our model which predicts the shelf-life of fruits and vegetables which is also an important factor to avoid food wastage. By determining the shelf-life of the products, we can determine which products can be stored in the warehouse for some time or be transported over long distances be it for export or storage. i.e., the products with a longer shelf-life. While the products with shorter shelf life can be transported to local stores and sold in a short period thereby avoiding wastage.

# II. LITERATURE SURVEY

There are different approaches had been presented by different researchers starting from background subtraction to CNN. Some of the human tracking methods have been presented in this section.

Human tracking consists of three basic steps for pedestrian tracking: Human detection from sequence of frame, tracking and analysis of the tracking for particular purpose. Deep learning-based low-cost machine vision system for grading the fruits based on their outer appearance or freshness. Various state-of-the-art deep learning models and stacking ensemble deep learning methods were applied to two data sets of fruits. The results of this study show that Efficient Net [CNN](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/neural-networks) models and their stacked combinations have the highest accuracy in grading the test set and real samples as compared to the other deep learning models. [1]

A framework for learning and classifying bananas is developed first. It uses neural network technology to detect the fruit's ripening stage.

Due to the complexity of the banana fruit's ripening stages, it is necessary to develop image processing tools that can identify the various fresh incoming bunches.

The goal is to create an image processing system that can detect the different stages of the fruit's ripening process. This method would help determine the optimal eating quality and the price of bananas. [2]

Computer vision is a widely used technique for processing images. It has enormous potential in terms of image processing and farming.

In this paper, we study the various aspects of machine learning for the classification of fruits and vegetables. Through a variety of data sources, we found that SVM achieves better accuracy than other machine learning techniques.

In this paper, we perform the Recognition and classification of fruits and vegetables and detection of disease in fruits and vegetables among the horticulture products under the agriculture field using computer vision.[3].

This paper proposed a classification model for maturity status classification of papaya fruits in two approaches, machine learning and transfer learning approach.

Overall, the VGG19 is better as VGG19 is based on transfer learning, there is no requirement of feature extraction and feature selection process. Although the transfer learning approach needs complex architecture, high training time and large datasets it is one time only.

However, the achieved accuracy in both machine learning and transfer learning is 100% and beat the previous method i.e., 94.7% of accuracy. [4].

# A deep learning-based framework for fruit classification was proposed in this work. Two CNN models were investigated in the proposed framework, a small CNN model, and a VGG-16 fine-tuned model.

# The VGG-16 fine-tuned model achieved excellent accuracy on both datasets.

# The light CNN model also achieved excellent accuracy on dataset 1 with data augmentation

# The performance of the two models has been compared with two other methods in the literature. It was found that the two proposed models outperformed the two existing methods on dataset.[5].

# The proposed paper tells us they have created a fuzzy model to check whether the fruit banana is ripe, unripe or overripe. For this they have used Regression Tree Algorithm and also the classification method. This process is evaluating the banana on different ripening stages on the MUSA database.[6]

In this paper, it is used to classify the fruit by capturing the image of the fruit using a camera. To classify the fruit, multi-class kernel support vector machine (kSVM) is used. Then the split and merge algorithm is used to eliminate the background of the image and focus only on the fruit. Next will rely on the shape, texture and also the color histogram to get a proper feature space and to minimize the dimensions of the feature space by principal component analysis (PCA).[7]

The proposed paper tells us that convolution neural network is used for object recognition and some of the important components for the information processing system and decision -making system are recognizing the visual image. CNN is mainly used for the detecting the fruit and recognizing the fruit too.[8].

In this paper, it has been discussed there may arise a human error while checking the quality of the fruit so using image acquisition and image classification for checking the fruit quality and three important factors used are image segmentation, image pre-processing, Classifier. In addition to this k-means clustering is used to achieve better improvement of accuracy and speed of the classifier.[9].

In this proposed paper, it is discussed about apple defect detection where first the apple image is captured and then background are deleted and the algorithm used in this paper is e Fuzzy C-means Algorithm and the Nonlinear Programming Genetic Algorithm (FCM-NPGA) and for multivariate image analysis. Using this algorithm the image of apple that is apple is examined every angle so that the defect can be found easily.[18].s

# III. METHODOLOGY

The proposed method is based on Machine Learning and uses transfer learning as well as computer vision and algorithms to automate the process of quality analysis of fruit and vegetable and to predict shelf-life. SDD is based on the Single Shot Detector Algorithm, which is faster and has a high object detection accuracy.

The VGG-16 base network for SDD is standard CNN architecture for high-quality image classification, but without the final classification layers.

The overall flow of the proposed system is presented in Various state-of-the-art deep learning techniques were initially trained and tested for the fruits’ image data sets and then these off-line models for each technique were saved and deployed for real-time testing.

The components of the system are explained in the subsequent sub-sections algorithm is used.

In order to develop the real-time visual inspection system for grading the fruits, deep learning models were trained and tested using the existing data sets. The details of the data sets, image pre-processing and training/testing of the models are described below.

The system can work both in offline and real time mode and can accurately grade the multiple instances of the fruits in a given image or real time using efficient segmentation process.

# IV. RESULTS

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