

Survey Paper on Fruit Recognition, Classification and Quality Health Maintenance

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Abstract

This research focuses on fruit and vegetables classification, recognition based on its health and quality by using Raspberry pi board, which is further integrated with digital image processing techniques and machine learning concepts. Convolutional Neural Networks (CNN) is generally used to perform image identification and categorization in the object recognition systems. The recent advancements in deep learning-based models assist in performing complex image recognition. This study also proposes an effective CNN-based method for performing fruit recognition, fruit maturity based categorization, and calorie estimation. Datasets are used to train the proposed machine learning model. The dataset used here is a combination of image data containing various types of fruit; here the proposed cost-effective yet powerful fruit quality maintenance method will be useful for fruit vendors and farmers.

Keywords: *Convolution neural networks, raw-ripe, raspberry pi, machine learning, image recognition.*

1. Introduction

This study outlines how fruit grade and quality are often assessed using Raspberry Pi. Food is obviously essential for human survival. Inadequate management and disposal might result in sickness. This occurs as a result of the majority of bacteria being undetected and unseen. Additionally, these bacteria normally don't alter the flavour, aroma, or appearance of fruit. That's the reason, it should examine how to avoid illness (salmonella poisoning) and

explain how to eat fresh foods. With image processing and other emerging technologies object detection is being exploited to its complete potential. This generally be seen in food-based industries for fruit recognition and classification. Fruit categorization in this case is a challenging issue because of all the possible variations; it opens new opportunities for researchers to address the issues. With reference to those issues, we are proposing a method for fruit detection and classification. The primary goal of this endeavour is to identify the fruit and classify it based on its ripeness i.e., raw or ripe and to get the count in addition as total calorie estimate of the fruits detected in an exceedingly single frame. This will be accomplished based on its shape, size, texture and color. To achieve these objectives, we make use of deep learning techniques like Convolution Neural Networks (CNN) along with image processing.

2. Associated Activities

Fruit identification and categorization are thought to be hard tasks that still face some difficulties. There are obstacles to be overcome in order to produce the ideal fruit identification and categorization technology. This section of the article shows the work of scholars who have made an effort to use various ways to overcome some of the challenges faced. The following research highlights work that has been done. Additionally, each paper is critically analysed based on the issue the researcher is trying to solve, the type of data utilised, the methodology employed, potential future work, and benefits and drawbacks.

2.1 Automatic Fruit Classification Using Deep Learning for Industrial Applications

Paper has two different approach on deep learning model architectures are used for fruit classification which is autonomous. The first strategy uses a special model with six Convolutional filters, while the other uses a fine-tuned visual group that is made up of 16 pre-trained DL models. Two colored image datasets are used. Clear fruit images and the other one is fruit images that are difficult to predict. Accuracy on both datasets is achieved, this can be considered as advantage. And on the other hand disadvantage is that the proposed model can only detect the fruit classification but does not give the count, ripe or raw classification and calorie estimation [1].

2.2 Colour Image Segmentation for Fruit Ripeness Detection: A Review

In this study, many methods are utilised to gauge the maturity or rate of ripening of fruit and veggies. This article discusses picture segmentation methods include histogram

matching, algorithm-based segmentation, and segmentation based on relative parameter values. These methods employ illustrations of fruits and veggies as the system's input data. The maturity level of the supplied fruits and vegetables may be determined using these procedures by correlating the input data picture with specified threshold values that are predetermined. Increase in accuracy for detection of rate of ripeness of fruit by comparing other image segmentation techniques. This paper presents a simple method to determine the ripeness level of the following fruits and veggies is an advantage, on other hand disadvantage is that Histogram match and the sorting method needs colour spatial transformation and these algorithms are used only to detect ripeness of the fruit. No count and calories of fruits can be estimated [2].

2.3 Automatic Fruit Detection System using Multilayer Deep Convolution Neural Network

This paper presents a CNN based approach for automatic detection of fruits. The proposed system uses fruits 360 dataset which comprises of 6783 photos divided into 12 groups. The method includes CNN layers, pooling layer for feature extraction but also stimulation mechanisms like Softmax and RELU. Here max pooling is used as it elicits as well as resizes picture pooling that is better to the norm. Advantage of This proposed method is to increase the accuracy for detection of fruits. Disadvantage of This paper presents a simple method for only detection of fruits [3].

2.4 Fruit Ripeness Based on RGB, HSV, HSL, $L^*a^*b^*$ Color Feature Using SVM

This study takes into account a dataset of fruit ripeness for 8 groups, which are raw Mango, raw Tomato, raw Orange, and raw Apple, together with Ripe Mango, Ripe Tomato, Ripe Orange, and Ripe Apple. The model used here is Fruit ripeness prediction using the SVM programming code Have used RGB, HSL, HSV, and $L^*a^*b^*$, Here $L^*a^*b^*$ color refer as CIELAB, (The International Commission on Illumination, often known as CIE, established the CIELAB colour space, also known as $L^*a^*b^*$, in 1976. To avoid confusion with Hunter Lab, CIELAB should not be referred to as "Lab" without the asterisks) features contained in fruit. Advantage of proposed model is created employing 6th degree polynomial kernel and with HSV colour characteristics with a precision and recall score of roughly 0.76, and the finest F-Calculated value was 0.78, the finest retention 0.76, and the highest accuracy was 0.80. The main disadvantage is it uses four different classifiers for performing the same task in order to make the system more complex and difficult [4].

2.5 Ripe-Unripe: Machine Learning based Ripeness Classification

This work suggests a system for determining according to the colour of the fruit, it might be either mature or immature. They have used CNN model for recognition as well as classification. The image is processed items that have three dimensions, such as height, breadth, and length. To build a CSV that is employed for training, there are three main levels in total depth. Once the training is done RGB encoding is employed. Complete accuracy in classification of about 3-6 fruits. The implementation's drawback is that it requires manual picture input in order to summarize and identify fruits [5].

2.6 Fruit recognition system for calorie management

In this paper they proposed a method for fruit recognition along with calorie estimation. They have proposed a method involving segmentation to exact images using k-mean clustering, colour fragmentation, texturing tools, and a few more components of the cloud SVM process for fruit recognition. For calorie estimation they trained a data set with calorie table for each fruit label. It is able to detect the fruit accurately with precision mostly above the rate of 80%. The true positive cases are rather considerably high this can be considered as advantage, on the other hand disadvantage is Accurate calorie estimate is not obtained as the calories depend on the size and weight of the fruits. Here the datasets are rather rigid. CNN models require high performance systems and coaching the signal requires more executable time [6].

2.7 Analysis of visual features and classifiers for Fruit classification problem

In this paper they have analyse the visual features and classifiers that contribute the most while identifying a fruit. As per this paper colour, size, breadth, and length of fruit texture, and shape are the most often used qualities for fruit categorization. The proposed methodology involves following techniques: Support Vector Machine (SVM) multi class, K nearest neighbour (KNN), Naïve Bayes (NB), Decision Trees (DT), Linear Discriminant Analysis (LDA), Back Propagation Neural Network (BPNN). Advantage of The suggested algorithm can able to categorise, by better accuracy as analysed with existing approaches, a diverse range of comparable fruit groups distinguished by characteristics such as colour and texture Six well-known classifiers are applied, and the results are compared. The best results are obtained with Back Propagation Neural Network, SVM, and KNN' classifiers. The disadvantage of the suggested technique has not been tested in a crowded or obstructed environment for fruits [7].

2.8 Automatic classification of fruit using random forest algorithm

This research article proposes a method to employ fruit classification using Random Forest classifier. The aim is to achieve fruit detection and classification based on training datasets. To recognise different types of fruits, the proposed model employs the Random Forests (RF) classifier. The fruit training data-set feature vectors with their corresponding classes, are fed in this stage. As in the testing data-set, whose output is fruit class name for each image. Advantage of this paper is that The RF classifier is compared with KNN and obtained following results. Classifying fruit images with KNN (71.42 percent orange and 72.72 percent strawberry) and with RF (87.50 percent orange and 90.91 percent strawberry), using shape and colour as feature extraction which results in lower precision. When they run the system with 70 percent training and 30 percent testing, they get higher precision (71.42% orange and 72.72% strawberry). The RF classifier achieves 100 percent precision during feature extraction of shape and colour, using SIFT as feature extraction with both KNN and SVM classifiers. On other hand disadvantage of paper is that the training data-set is 60% and testing size is 70%, orange obtains a lower accuracy than apple, because of utilising the SVM classifier for feature extraction which is good precision for detecting apple pictures [8].

2.9 Calorie Estimation in food using Convolutional Neural Network (CNN)

This paper describes a model for calorie estimation using deep learning algorithm. The authors have used ECUSTFD for food dataset that includes records of food volumes and masses as well as captioned images. The proposed method uses Tensor Flow's Object identification API to identify food in images, as well as SVM and random forest methods with CNN to improve accuracy. The calorie is estimated using the formula $C = c * \rho * v$, where C is the estimated calorie, c is calories per gram, ρ is average density of food and v is the estimated volume. In this proposed CNN model the estimated volume inaccuracy is steadily decreased by 20%. Where it suggests, the increase in accuracy for estimation of calorie can be said as advantage of this paper. Limitation is it doesn't concentrate on classification of food [9].

2.10 Detection and Counting of Mango Fruits in Occluded Condition Using Image Analysis

By assessing the colour filter, this study provided an approach for recognising and counting the quantity of mangos in obstructed condition. This approach calculated histogram intensity. Threshold calculation for segmenting the fruit item from its backdrop based on

morphological procedures performed on each RGB colour channel. Following histogram filtering and hierarchical clustering, the information obtained from the generated blobs was completely utilised in this study. This approach did not need figuring out how many clusters needed to be searched, and thus had a reduced efficiency cost. Disadvantage is that it cannot be used under overexposed illumination circumstances for fruit object detection and counting.

3. Future Work & Conclusion

The primary goal is to classify, identify ripeness, and maintain the fruit's quality. When it comes to fruit identification, there are numerous factors to consider, such as shape, size, texture, and colour. These visual characteristics are the most important in identifying a fruit. Generally, Convolution Neural Network architectures like YOLO V4 for performing fruit detection and further the fruit recognition is accomplished by mapping those visual features. YOLO works based on object detection; the number of fruits can be obtained by using image segmentation techniques such as blob detector. Fruit ripeness classification is accomplished through image processing and colour transformation, with fruits classified as ripe or raw based on saturation level. To achieve real-time application, a Raspberry Pi board has been used with an integrated camera to capture live data and output it to a digital screen. Datasets are used to train the model for delivering an effective and accurate output; the model's accuracy increases with the size of the data collection. Different variety of fruits are successfully recognized by using the dataset.

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