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Fruit Counting and Maturity Detection using Image Processing: A Survey

Vina M. Lomte[1], Shalmali Sabale[2], Rugveda Shirgaonkar[3], Pranali Nagathan[4], Priyanka Pawar[5]
[1]*Professor & HoD, Department of Computer Engineering, RMD Sinhgad School of Engineering, Pune, India*
[2,3,4,5]*Student, Department of Computer Engineering, RMD Sinhgad School of Engineering, Pune, India*

***Abstract*: In agriculture sector the problem of identification and counting the number of fruits on trees plays an important role in crop estimation work. At present manual counting of fruits and vegetables is carried out at many places. Manual counting has many drawbacks as it is time consuming and requires plenty of labors. The automated fruit counting approach can help crop management system by providing valuable information for forecasting yields or by planning harvesting schedule to attain more productivity. This work presents an automated and efficient fruit maturity detection and fruit counting system using Image Processing.**

***Keywords*: Image Processing, Fruit classification, fruit maturity, fruit size, color index, Maturity level.**

1. Introduction

Fruits play an important role in keeping the body healthy and have numerous benefits. Aroma and taste of the fruit are determined by its maturity level. Owing to lack of storage facilities in developing countries like India, huge quantity of fruits is wasted. Therefore, there should be a method to determine the maturity level of harvested crop. Fruit market is getting highly selective, requiring their suppliers to distribute the fruits of high standards of quality and presentation as well. So there is a increasing need to supply quality fruits within a short period of time has given rise to the development of automated Grading of fruits to improve the quality.

In India, this task is still performed by human labourers. But the manual method used for classifying the harvested crop is very time consuming, painstaking and inefficient because human perceptions can be easily fooled. It is the need of the hour to use non-destructive maturity determination techniques for making the agricultural operations more economical. Various systems have been developed by the researchers but due to low efficiency and high cost, it is not viable to implement these systems at industrial level. So it is very crucial to analyse the advantages and disadvantages of existing systems for further developing the efficient system. Colour, size and texture are key parameters for judging maturity. Quantification of these visual properties can significantly improve the agricultural management tasks.

A. Image processing

Image processing is any form of information processing for which the input is an image, such as photographs or frames of video; the output is not necessarily an image, but can be for instance a set of features of the image. Most image-processing techniques involve treating the image as a two dimensional signal and applying standard signal processing techniques to it.

A pixel, short for picture element, can be thought of as a tiny dot containing information about the picture. When you snap a picture, these tiny bits of information are gathered by the camera's sensor. The information is being stored in a 3 plane of information. Each plane represents three colors that are red, green and yellow plane. Each plane has the intensity from 0 up to 255 or 8-bit of information per plane. These three color combination makes up all the color we could see in an RGB images. Simple calculation of this are 8-bit information is as follow: 2n = bit, 28 = 256

The origin of this size started when the byte was introduced back then in the origin of information capacity now have its standard.

Many of the techniques of digital image processing, or digital picture processing as it was often called, were developed in the 1960s at the Jet Propulsion Laboratory, MIT, Bell Labs, University of Maryland, and a few other places, with application to satellite imagery, wire photo standards conversion, medical imaging, videophone, character recognition, and photo enhancement. Digital processing is most of the time preferable because of cost issue on top of falling trend of digital devices.

B. Fruit maturity identification

RGb*, grayscale is used for find different between maturity stages. The length and aspect ratio does not affect the ripeness of fruits. Here the fruit Classified into three based on maturity they are unripe, ripe, and overripe. CNN algorithm can be used for classifying the fruit maturity.

The Mango fruit maturity detection is done using its external color. Special species mangos known as “Langdo” had the same color in its life span. In this case here x-ray, infrared are used and photos of mango taken using thermal camera.

Fruit Maturity Level Detection Framework:

Fruit Separation: Each fruit is separated from all fruits. We can check the maturity of each separated fruit. Also, we can detect the fruit type.

Preprocessing: In this phase, the separated fruit image will be preprocessed with any one of the following scenarios based on the can accuracy, i.e, convert the input RGB images to grayscale ii. keep the input images in the RGB color space iii. convert the input RGB images to the HSV color space iv. convert the input RGB images to the HSV color space and to grayscale and merge them.
The neural network is tested for each scenario.

Feature Extraction: In preprocessing we can extract the features like,

1. Fruit Color
2. Black Spot
3. Black Linings
4. Linings or patch patterns etc.

Detect Maturity Level: We can apply Machine learning algorithm i.e. CNN on the trained dataset to detect that whether the fruit is mature or not and also the fruit type. By using an image processing we can easily recognize the fruit type and their maturity level.

Training and Testing Using CNN Algorithm: For the training and testing the fruit maturity we use the different type of fruit data set. We use the kaggle dataset for training and testing from following link, https://www.kaggle.com/moltean/fruits

CNN Algorithm: The CNN algorithm is used for data classification. Convolutional neural networks (CNN) are part of the deep learning models. Such a network can be composed of convolutional layers, pooling layers, ReLU layers, fully connected layers and loss layers. In a typical CNN architecture, each convolutional layer is followed by a Recited Linear Unit (ReLU) layer, then a Pooling layer then one or more convolutional layer and ally one or more fully connected layer. A characteristic that sets apart the CNN from a regular neural network is taking into account the structure of the images while processing them. Here we used the 80% of data set for the training purpose and remaining 20% dataset used for testing.

2. Literature review

"Anisha Syal", et.al introduces minimum Euclidean distance based segmentation technique for segmenting the fruit region from the input image. Further circle overlaying is done on the fruit region and in the last fruits is counted on the basis of the centroid of the fruit regions. The system is correctly detecting and counting the apples on the test images.

"Bhushan P. Ragit," et al describes processing based yield counting system and health monitoring of citrus fruit is being processed. The model which is explained in the paper can be worked in any graphical area. The system consists of an automatic robot which revolves around. The axis of citrus tree and clicks various images from different angle. Then this images are processed by image processing algorithm and color based counting of fruit is presented at the output. The system is being designed to automatically and accurately calculated the yield of citrus group tree and health monitoring is temperature and moisture of tree is also included in system.

"Izadora Binti Mustaffa", et.al focuses on the identification of maturity of mango fruit. Raspberry Pi is a small computer, which is powerful enough to run an image processing algorithm is chosen for this system. The developed image processing algorithm is able to determine the size of the fruit and apply the K-means clustering to determine the fruit color

"S.Arivazhagan" et al describes computer vision strategies used to recognize a fruit rely on four basic features which characterize the object: intensity, color, shape and texture. This paper proposes an efficient fusion of color and texture features for fruit recognition. The recognition is done by the minimum distance classifier based upon the statistical and co-occurrence features derived from the Wavelet transformed sub- bands. Experimental results on a database of about 2635 fruits from 15 different classes confirm the effectiveness of the proposed approach.

"Pradeepkumar Choudhary", et.al Fruits should be quickly and correctly differentiated from their surroundings for the fruit harvesting robot. Edge based and color based detection methods are generally used to segment images of fruits obtained under natural lighting conditions. In this work, Digitized images of mango fruits along with its background were selected from the Internet in order to find a mango in each image and to locate its exact position. We compared the results of Edge based and colored based segmentation results and found that color based segmentation outperforms the edge based segmentation in all aspects. The comparison results are shown in the segmented image results. Accordingly, a new mango detection method is proposed to position the centroid of mangoes.

"AnujaBhargava" et al Presents a detailed overview of various methods i.e. preprocessing, segmentation, feature extraction, classification which addressed fruits and vegetables quality based on color, texture, size, shape and defects. In this paper, a critical comparison of different algorithm proposed by researchers for quality inspection of fruits and vegetables has been carried out.

"Harpuneet Kaur" et al sheds light on the advancements made in the automated agricultural industry. Digital image processing techniques are now widely used for maturity estimation of fruits and vegetables. This work aimed to study and analyze the various algorithms and feature extraction techniques that are now used for extracting features from the captured digital images. Advantages and disadvantages of various classifiers have been discussed. It was observed that for achieving high accuracy a compromise is to be made with high computational complexity

"Shubham Tagad.", et.al introduced an assisting application for fruit maturity estimation. The specialty of this system is, it can tell the number of remaining days for ripening of the fruit. One of the three main modules, user will store his information in the system as well as he will click the image of the fruit for its maturity detection. Database will contain the training dataset of fruit. It will also store the user information. Server will pre-process the image given by user and compare its characteristics

with characteristics of fruit images stored in database. This system is easy and cost effective technique for maturity detection of fruit. Other fruit maturity detection techniques like use of infrared rays and chemical testing are harmful, it can damage the fruit. This system uses image processing to store the characteristics of fruit. Gaussian blur and sobel edge detection algorithm are used to acquire the characteristics of the fruit.

"Mr. Sumit S. Telang", et al This paper aims at presenting the concept of fruit quality management, In recent years automatic vision based technology has become more potential and more important to many areas including agricultural fields and food industry. The desired system which determines the quality of fruit by its color, size and weight. Sorting tons of fruits manually is a time consuming, costly, and an inaccurate process and to developed in order to increase the quality of food products made from fruits. The sorting process depends on capturing the image of the fruit and analyzing this image using image processing techniques to discard defected fruits. Color is most striking feature for identifying disease and maturity of the fruit. The main emphasis is to do the quality check with a short span of time so that maximum number of fruits can be scrutinized for quality in minimum amount of time. The absolute reference point is the way to perceives and interpret the quality of fruit. The present assessment of fruit

quality requires new tools for size and color measurement and capturing the fruit side view image, some fruit characters is extracted by using detecting algorithms.

"Izadora Binti Mustaffa", et al describe that color and size are one of the most important features for accurate maturity classification of fruits. Small business farmers use manual evaluation through visual observation to classify the maturity of their pick. Which according to FAMA there are six maturity indexes? The repetitive process is tedious and is prone to human error. This paper focuses on the identification of maturity of mango fruit. Raspberry Pi is a small computer, which is powerful enough to run an image processing algorithm is chosen for this system. The developed image processing algorithm is able to determine the size of the fruit and apply the K-means clustering to determine the fruit color.

3. Existing system

Image processing in agriculture is the major fast growing research areas. The use of image processing in the food industry mainly in fruit classification grading maturity identification and detection.

Image processing technique involves five steps: namely, image acquisition, pre-processing, image segmentation, feature extraction and classification.

A. Flow Diagram of identification

1) Pre-processing steps

In all works considered for review, preprocessing has been the essential first step of the for classification, grading, maturity identification and defect detection activities. The fruits were captured using digital camera either set up an image capturing system or shot directly. The pre-processing technique standardizes the orientation and scale of the captured images. The main methods found are,

1. RGB to gray conversion.
2. Binary conversion.
3. Noise reduction.
4. Contrast stretching.
5. Histogram equalization.
6. Background elimination.

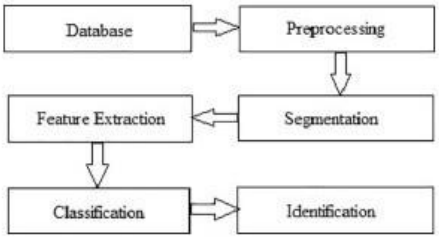

Fig. 1. Flow diagram

2) Feature extraction steps

Feature extraction is an initialization from the measured data and derived the features of the images. In here the different features extracted from the fruits. This section gives an idea of different features used for the operation. Mainly used features are,

1. Shape.
2. Size.
3. Texture.
4. Color.

3) System Architecture

The working of system is as follows, Fig. 2, show the architecture of proposed system.

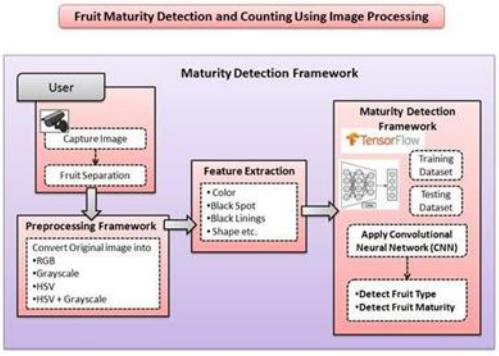

Fig. 2. Maturity detection framework

4) Classification Methods

1. Fuzzy logic.
2. Support vector machine.
3. Convolutional Neural Network (CNN) Algorithm.
4. K-Nearest Neighbor

Table 1
Classification accuracy comparison

Algorithm	Accuracy	Rank
GA-FNN [1]	84.8%	5
PSO-FNN [4]	84.9%	4
ABC-FNN [5]	85.4%	3
k- SVM [8]	88.2%	2
HPA-SLFN [3]	89.5%	1

B. Advantages

1. To detect fruit maturity level.
2. To detect fruit count using image processing technique.
3. To automated sort the mature fruits.

C. Applications

1. To sort the fruits by maturity level.
2. Fruit counting using image processing.

4. Conclusion

This work survey and analyzed that how fruit counting and fruit maturity detection is essential factor in agriculture sector. The Image processes sing technique used for fruit maturity detection on captured digital image of different fruits. Various algorithms and feature extraction techniques that are now used for extracting features from the captured digital images. Various classifiers have been discussed. Hence, the extension of this work will review all above mentioned techniques and methods we can conclude that there are number of ways by which we can detect fruit maturity.

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