Fruit Grading System using Computer Vision Techniques DebasmitaBhoumik

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Abstract—Digital image processing, along with computer vision techniques, can be applied for automatic gradation of fruits based on the quality depending on the fruit type. It can increase the commercial value of the production. This paper presents an automated approach for fruit grading. First, it classifies the type of the fruit by using the SURF (Speeded Up Robust Features), and then after classification, it detects the grade of the fruit - A (good), B (medium) or C (bad). For gradation we have used the color features and area of the fruit. Minimum distance classifier is used for the classification. The average accuracy for fruit detection and grading are 87.48% and 78.9% respectively.

Keywords—Fruit Detection, Fruit Grading, SURF, Color Feature, Minimum Distance Classifier

I. INTRODUCTION

New trends in cropping pattern have been recognized for changing the status of rural community. Previously manual fruit grading was done, which is expensive for labour cost and is also time-consuming. The growing need to supply high quality food products within a short time is promoting the automated grading of agricultural products, which can be done by using computer vision for quality inspection and evaluation purposes. Different features of flabbiness, segmentation level, color, size and shape are the essential quality of natural image and it performs the significant role in visual perception. Grading can fetch higher price and also improves packaging, handling and other post harvesting operation. Grading is basically separating the material in different homogenous groups according to its specific characteristics like size, shape, color and on quality basis. There are various types of grading like- Size Grading, Weight Grading, Screen Grading, Electronic color grading and reflectance grading and Image processing in fruit grading.

The application of machine vision in agriculture has increased considerably in recent years. In past, much research work has been carried for automated grading of fruits.

The size gradation technique using mechanical roller belt for distinguishing large and small sized fruits are modelled [1,2,3]. Various models are suggested for weight based gradation of fruits [5,6,18]. A square mesh riddle system with reference to uniformity, accuracy, damage and capacity are used for gradation of potatoes [7]. They have used quality sorting by hand selection, semi-automatic and electronic methods. In [8] they have studied online fruit grading according to their external quality using machine vision. The apples are graded into four classes according to European standards. Few other researchers [9, 10, 11, 12] have proposed various methods involving computer vision techniques for fruit grading. A detailed review on these techniques are available in [4].

The main contribution of our proposed method is, development of an automated system for-

1) Recognition of the fruit.

2) Grading of harvested fruit.

The novelty of this work is – we are proposing a system which can be used to grade any class of fruits. It is using Speeded-Up Robust Features (SURF) algorithm for the fruit recognition. So that after detection it can grade the same. So the system is generalized, whereas most of the other fruit grading systems are limited to one class of fruit only. SURF can detect a specific object based on finding point correspondences between the reference and the target image. It can detect objects despite a scale change or in-plane rotation.

The paper is organized as follows. Section 2 describes the proposed methodology that includes image pre-processing techniques, texture feature extraction using statistical methods and classification using above mentioned classifier. Experimental results are shown in section 3 and we conclude in section 4.

II. METHODOLOGY

There are 2 sections involved in this work. First we have to identify and recognize the fruit, then we have to grade the fruit's quality. Therefore, the first phase is fruit identification. Identification can be done based on various information such as color, texture (surface information) and shape, size (geometric information). Here we are focusing only on the surface information to characterize the object. This will be an efficient fusion of color and texture features for fruit recognition.

The recognition consists of two parts-

- 1) Training
- 2) Classification

For training, we first have to pre-process the image. In real situation it is necessary to cope with illumination variations, background clutter, shading, and shadows. In order to reduce the scene complexity, it might be interesting to perform background subtraction and focus in the object's description.

For grading, the captured fruit images are sent to the computer for the purpose of analysing (using Matlab). Then it calculates the area and size of that captured fruit image. The captured image can be compared with the stored database. If matching is found in the database, it will be selected for further processing and sort the fruits grade wise (Grade A or Grade B or Grade C) ,otherwise it will not selected.

Algorithm of the system:

- 1) Read the image both for training and testing.
- 2) Then Pre-process the image for further feature extraction.
- 3) Create Database of various kinds of fruits, and for each class of fruits there will be a sub class of good, medium and bad quality sample of images.
- 4) Collect Image Features (SURF) to classify in which class the fruit falls. (Here we have tested with apple, orange and pineapple)

- 5) After detecting the fruit, we have to measure the quality; this module calculates area &colour of that particular fruit.
- 6) Gradation is done after matching with database and result in grade A, B, C.

The flowchart is given below



Fig. 1: Flowchart of the system

A. Image Preprocessing

We have to ensure all images are taken from a fixed distance so that the area comes irrespective of the camera's distance from fruit. Then all images are re-sized to a fixed size and noises are removed using Gaussian Filter. The imadjust() function is used for improving image contrast in MATLAB. This increases the contrast of the output image.

B. SURF

The SURF [13] method (Speeded Up Robust Features) is a fast and robust algorithm for local, similarity invariant representation and comparison of images. The main interest of the SURF approach lies in its fast computation of operators using box filters [14] thus enabling real-time applications such as tracking and object recognition. When considering the image matching task, the local descriptors from several images are matched. Exhaustive comparison is performed by computing the Euclidean distance between all potential matching pairs. SURF approach approximates the Gaussian kernels and its spatial derivatives by uniform kernels with rectangular (thus separable) support, referred to as box filters. Using SURF, we can detect a particular object in a cluttered scene, given a reference image of the object. First we detect the SURF features. Then we visualize the strongest feature points found in the reference image. Then we match the features using their descriptors. After that, we calculate the transformation relating the matched points, while eliminating outliers. This transformation allows us to localize the object in the scene.

C. Area Calculation

The area is detected using the following method [15].

To obtain an index of measuring image-processing method, two images were chosen and after doing pre-processing section, the binary image was obtained. Then, the area of the section, which was detected as the fruit, was obtained by pixel from this image. The superficial shape of most fruit was similar to spherical body. So the radius is the same as radius of sphere. Therefore by using obtained area of circle from image processing method, we can calculate r (radius) by pixel from relation. As indicated, in order to calibrate, it was used of two images of each class of samples obtained randomly.

D. Color Detection

Here the colors are detected using RGB values. So for e.g., two fruits are considered, say Apples having red color and Guava having green color. So in this step, we are going to find out the color of a fruit. We have used a Color detection algorithm [16]

- 1) Read the input pixel of color image in three different planes (RGB) and store it into three variable r1, g1, and b1.
- 2) Read them from different location (pixels) of image and then Calculate the mean of r1, g1, b1 and store into variable r2, g2, b2.
- 3) We can store these values in database for each classes of fruits and later it can be matched with our test fruit.

The classification is done using the Minimum Distance Criterion [17]. The image from the training set, which has the minimum distance (Euclidean) when compared with the test image, says that the test image belongs to the category of that training image.

III. RESULT

All the image pre-processing, feature extraction and classification techniques in our proposed method are simulated in MATLAB 8.5 (R2015a) and run on an Intel(R) Core(TM) with 4-GB memory. The number of images used for training and testing, along with entries from each grade are listed below. Table 1 shows the total number of images used for training and testing for each of Apple Orange and Pineapple. Table 2 shows the number of fruit images for grade A, B and C for each of Apple Orange and Pineapple in training and testing case. Table 3 shows the fruit recognition rate and the Table 4 shows the accuracy for Grade Detection.

Serial No.	Fruits	Total	Training	Testing
1	Apple	30	20	10
2	Orange	35	25	10
3	Pineapple	25	15	10
Total		90		1
Table 1. List of images used for experiment				

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Serial	Fruits	Training (Grade)			Testing (Grade)		
INO.		А	В	С	Α	В	С
1	Apple	8	6	6	4	3	3
2	Orange	8	9	8	4	3	3
3	Pineapple	7	4	4	4	3	3

Table 2:	List of image	es of specific	grades used for
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	8 I 8				
	experiment				
	Serial No.	Fruits	Recognition Rate		
	1	Apple	89.95%		
	2	Orange	91.45%		
	3	Pineapple	81.06%		
Table 3: Result of detection of fruits					
	Serial No.	Fruits	Grade detection Rate		
	1	Apple	81.95%		
	2	Orange	80.8%		
	3 Pineapple		73.96%		

 Table 4: Result of detection of fruit grades

The Performance of all classifiers can be tested and evaluated by the following parameter:

Accuracy rate = correctly classified images / Classified images.

The average accuracy for fruit detection is 87.48% and for fruit grading the accuracy is 78.9%.

IV. CONCLUSION

The main advantage of this method is the use of computer vision instead of depending on the human expertize. We have obtained an accuracy of 87.48% for fruit detection and for fruit grading the accuracy is 78.9%. Hence, it can be concluded that our proposed method is very much efficient for automated fruit grading from images. We can extend this work by incorporating more number of fruits and more classes. For classification, SVM can be used to increase accuracy. We can incorporate the shape feature to detect more precisely the quality of the fruit. This method is intended to help the agriculturalist and farmers by freeing them from the burden of time consuming manual gradation.

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