IoT Based Fruit Grading System

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***Abstract*: Digital image processing is one of the popular computer vision techniques, which can be applied for automatic grading of fruits. Which will increase the business worth of the assembly. This paper presents an IoT-based approach for fruit grading. First, it classifies the kind of the fruit by extracting the SURF (Speeded Up strong Features), and after the classification, it detects the grade of the fruit namely- A (good), B (medium) or C (bad). For gradation we have used the color options and color space of the fruit. Minimum distance classifier is employed for the classification. The common accuracy for fruit detection and grading is achieved effectively up to 78.9%.**

***Keywords*: Computer vision, fruit grading.**

1. Introduction

New trends in cropping pattern are recognized for ever-changing the standing of rural community. Traditionally manual fruit grading is done, that is expensive due to labor price and is tedious and time consuming. The growing has to be compelled to offer top quality food merchandise inside a brief time is promoting the machine-controlled grading of agricultural merchandise, which might be done by victimization laptop vision for quality scrutiny and analysis functions. Completely different options of limpness, segmentation level, color, size and form are the essential quality of natural image and it performs the numerous roles in beholding. Grading will fetch higher value and conjointly improves packaging, handling and different post-harvest home operation. Grading is largely separating the fabric in several uniform teams in line with its specific characteristics like size, shape, color and on quality basis. There are varied kinds of grading like- Size Grading, Weight Grading, Screen Grading, Electronic color grading and reflection factor grading and Image process in fruit grading [1, 3].

The application of machine vision in agriculture has magnified significantly in recent years. In past, more research work has been carried for computer-vision grading of fruits.

The size gradation technique using mechanical roller belt is used for identifying giant and tiny sized fruits. Sufficient models such as square measure recommended for weight-based gradation of fruits. A square mesh riddle system with relevance uniformity, accuracy, damage and capacity square measure used for gradation of potatoes. They have used quality sorting by hand choice, semi-automatic and electronic strategies. In they need studied on-line fruit grading in line with their external quality mistreatment machine vision. The apples square measure ranked into four categories in line with European standards. Few alternative researchers have planned varied strategies involving pc-based vision techniques for fruit grading [6, 8].

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

1) Recognition of the fruit followed by the
2) Grading of the 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 the specific object based on finding point correspondences between the reference and the target image. It will notice objects despite a scale amendment 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 [11].

2. Methodology

There are 2 stages involved in this proposed frame-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 is done using 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 analyzing (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 be selected [10].

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 & color of that particular fruit.
6) Gradation is done after matching with database and result in grade A, B, C.
The flowchart of the proposed frame-work is given below

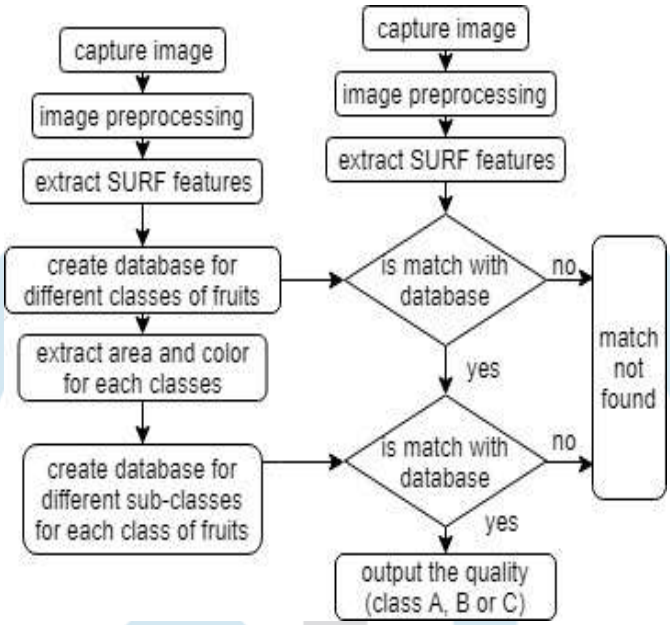

Fig. 1: Flowchart of the system

A. Image Preprocessing
We have to make sure all pictures square measure taken from a set distance so that the realm comes regardless of the camera's distance from fruit. Then all pictures square measure re-sized to a set size and noises square measure removed exploitation mathematician Filter. The imadjust() function is employed for up image distinction in MATLAB. This will increase the distinction of the output image.

B. SURF
The SURF technique (Speeded Up strong Features) could be a fast and strong algorithmic rule for native, similarity invariant representation and comparison of pictures. the most interest of the SURF approach lies in its quick computation of operator's exploitation box filters [14] therefore enabling period applications like trailing and seeing. When considering the image matching task, the native descriptors from many pictures square measure matched. Thoroughgoing comparison is performed by computing the Euclidian distance between all potential matching pairs. SURF approach approximates the Gaussian kernels and its special derivatives by uniform kernels with rectangular (thus separable) support, noted as box filters. Using SURF, we will find a selected object in an untidy scene, given a reference image of the article. First, we tend to find the SURF options. Then we tend to visualize the strongest feature points found within the reference image. Then we match the options exploitation their descriptors. After that, we calculate the transformation relating the matched points, while eliminating outliers. This transformation permits USA to localize the article within the scene.

C. space Calculation
The area is detected exploitation the subsequent technique [15]. To obtain AN index of mensuration image-processing technique, two pictures were chosen and when doing pre-processing section, the binary image was obtained. Then, the realm of the section that was detected because the fruit, was obtained by pixel from this image. The superficial form of most fruit was almost like spherical body. Therefore, the radius is that the same as radius of sphere. So, by exploitation obtained space of circle from image process technique, we will calculate r (radius) by pixel from relation. As indicated, so as to calibrate, it was used of 2 pictures of every category 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.

3. 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.

Table 1: List of images used for experiment

Serial No.	Fruits	Total	Training	Testing
1	Apple	30	20	10
2	Pineapple	25	15	10
3	Orange	35	25	10
Total		90		

Table 2: List of images of specific grades used for experiment

Serial No.	Fruits	Training (Grade)			Testing (Grade)		
		A	B	C	A	B	C
1	Apple	8	6	6	4	3	3
2	Pineapple	7	4	4	4	3	3
3	Orange	8	9	8	4	3	3

Table 3: Result of Detection of Fruits

Serial No.	Fruits	Recognition rate
1	Apple	89.95%
2	Pineapple	81.06%
3	Orange	91.45%

Table 4: Result of detection of Fruit Grades

Serial No.	Fruits	Grade detection Rate
1	Apple	81.95%
2	Pineapple	73.96%
3	Orange	80.8%

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%.

4. Conclusion

The main advantage of this method is the use of computer vision instead of depending on the human expertise. 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 a greater 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.

References

[1] J.Ramprabhu and S.Nandhini (2014). Enhanced Technique for Sorting and Grading the Fruit Quality Using Msp430 Controller. International Journal of Advances in Engineering & Technology. Vol. 7, Issue 5, pp. 1483-1488.

[2] Ali, M. A. H., Mailah, M., Tang, H. H., & Kazi, S. (2012). Visual inspection of cylindrical product's lateral Surface using cameras and image processing. International Journal of Mathematical Models and Methods in Applied Sciences, 6(2), 340–34

[3] Ali, M., Mailah, M., Kazi, S., & Tang, H. H. (2011). Defects Detection of Cylindrical Object's Surface using Vision System, 222–227.

[4] .Rupali S.Jadhav, & PROF. S.S.Patil. (2013). A Fruit Quality Management System Based On Image Processing. IOSR Journal of Electronics and Communication Engineering (IOSR-JECE), 8(6), 01–05.

[5] Seema, Kumar, A., & Gill, G. S. (2015). Automatic Fruit Grading and Classification System Using Computer Vision: A Review. Proceedings - 2015 2nd IEEE International Conference on Advances in Computing And Communication Engineering, ICACCE 2015, (I), 598–603.

[6] Chandan Kumar, Siddharth Chauhan, R. N. A. and H. M. gurram. (2015). Classifications of Citrus Fruit Using Image Processing -GLCM Parameters. In IEEE International Conference on Communications and Signal Processing (ICCSP), 1743–1747.

[7] Haan, P. H., and B. H. Van. 1987. Grading and sorting of potatoes. Wageningen, Netherlands, Pudoc (1987) 400-414. ISBN 90-220-0897-5.

[8] Leemans, Vincent, and M-F. Destain. "A real-time grading method of apples based on features extracted from defects." Journal of Food Engineering 61.1 (2004): 83-89.

[9] Al Ohali, Yousef. "Computer vision-based date fruit grading system: Design and implementation." Journal of King Saud University-Computer and Information Sciences 23.1 (2011): 29-36.

[10] B. Erdenee, T. Ryutaro, G. Tana, "Particular Agricultural Land Cover

[11] Classification Case Study of Tsagaannuur, Mongolia," in IEEE International Geoscience & Remote Sensing Symposium (IGRASS), pp. 3194-3197, 2010.

[12] V. K. Tewari, A. K. Arudra, S. P. Kumar, V. Pandey, N. S. Chandel, "Estimation of plant nitrogen content using digital image processing," in International Commission of Agricultural and Biosystems Engineering, Vol. 15(2), pp. 78-86, July 2013.

[13] M. Krishna, Jabert G., "Pest Control in Agriculture Plantation using Image Processing," in IOSR Journal of Electronic and Communication Engineering (IOSR-JECE), vol.6 (4), pp. 68-74, June 2013.

[14] G. Bhandane, S. Sharma, V.B. Nerkar, "Early Pest Identification in Agriculture Crop using Image Processing ," in International Journal of Electrical, Electronics and Computer Engineering, vol.2(2), pp. 77-82, 2008.

[15] J. K. Patil, R. Kumar, "Advances in Image Processing for Detection of Plant Diseases," in Journal of Advanced Bioinformatics Applications and Research ISSN, vol2 (2), pp.135-141, June 2011.

[16] T. Bronsnan, D. W. Sun, "Improving quality inspection of food products using computer vision- a review," in Journal of food engineering, vol. 61, pp. 3-16, 2004.

[17] Da-Wen Sun, "Computer Vision- an Objective, Rapid and Non-Contact Quality Evaluation Tool for the Food Industry," In Journal of Food Engineering, vol.61, pp.1-2, 2014

[18] H. H. Wang, D. W. Sun, "Evaluation of the Functional Properties of Cheddar Cheese using a Computer Vision Method", in Journal of Food Engineering, vol. 49(1), pp.47–51, 2002.

[19] N. B. A. Mustafa, K. Arumugam, S. K. Ahmed,Z. A. M. Sharrif, "Classification of Fruits using Probabilistic Neural Networks-Improvement using Color Features", IEEE International Conference on TENCON, 2011.

[20] R. C. Gonzalez and R. E. Woods, Digital Image Processing. Prentice Hall, 2nd ed., 2002. [19] Zou XB, Zhao JW, Li Y, Mel H. In-line detection of apple defect using three color cameras system. Comp Electron Agric 2010; 70(1):129–34.

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