An Image based analysis on fruit maturity-Review

Dr.K.Muthukannan[1], J.Petchiammal[2], S.Muthuveni[3], A.Rajeshwari[4]

[1]Associate professor, [2,3,4]Students
Department of Electronics and Communication Engineering,
Einstein College of Engineering, Tirunelveli, Tamilnadu-India

***Abstract*-Maturity is one of the important factors for finding the fruit quality. There is a great significance of agriculture in India. Grading system has been used to differentiate the various maturity stages in fruits. Maturity of fruits can be measured from the texture, shape, size and environmental changes. In this paper, usage of various methods classifies the maturity of fruits. By reviewing various techniques, the classification of maturity can be seen in detail**.

***Keywords*-Image analysis, color feature, shape feature, texture feature, fruits**

I. INTRODUCTION

The Firmness of the fruit indicates its maturity. Based on these maturity indices, the fruits can be classified into three categories viz., un-mature, mature and over-mature fruit. The most important parameters are size, shape, and texture. Maturity on the basis of image processing is very much useful to find out the fruit quality and reduce the manual grading. An image, which having a three basic colour component such as red component, green component, and blue component. Maturity based grading considers only the red component and green component. Most of the fruits will have its red colour in their maturity stage. Then, it will separate red component from other remaining components based on the features and also it will have the higher contrast. So it lead easily to grade the fruits using grading system. The basic steps for image processing is shown in fig: 1. First step is to collect the real data base images by using digital camera. The collected RGB images are pre-processed. Pre-processing is the process used to improve the quality of image in such a way that it increases the chances to attain success of further processes. It is the conversion of original image to a better understandable level in spectral quality for feature extraction. Next step is segmentation. It is the process by which pixels are grouped into segments according to their spectral similarity. After segmentation, features are extracted from that image. Classifier is used to classify the grading of Friuts

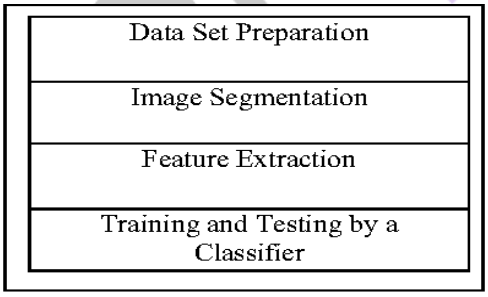

Fig:1 Basic image processing

II. LITERATURE REVIEW

From the past to recent years before, more number of techniques is used to improve the grading of fruits. But in India, fruits and vegetables are produced in huge amounts and still lack the scientific grading system. The scientific grading system of finding fruits is done by considering the size parameter only. Other parameters like shape, texture, firmness can be considered for perfect grading. Those areas following this principle, still lacking in image processing analysis techniques and methods which could be used to improve the quality of matured fruits.

H.Pasternak, et.al. (1997) has proposed to grading the tomato by using the techniques such as image compression (mohsenin, 19860, mechanical thumb (Mizrachi et al., 1992) and durometer (fallik et al., 1993). Maturity has been classified into two stages only (light red & red tomato).The RGB image is transferred to HSI for extracting the parameters. The median filter is used for the removal of noise. In this paper, the determination of green tomato is difficult.

K.Baldarasruiz,et.al. (2001) has proposed accurate image analysis of fruit disease development. This paper mainly based on three dimensional area measurements. The average error of that method is 0.1% and standard deviation is 0.44. Pseudo cylindrical

projection method is needed to be segmented for area measurement. This method is considered very difficult to standardize among different evaluations.

S.Renganathan, et.al. (2002) has proposed an automated fruit size grading. This technique provides a high accurate, reliable, consistence and handling large volumes with the help of contour image and grey scale images. The estimation of fruit can be done by estimating it's estimated by length and width. Chain encoding is used in this paper for boundary representation. Here, Fourier transform is used to specify the size and shape. This method is useful for realizing online automatic fruit sorting and grading based on the size.

O.Kleynen, et.al.(2004) has proposed some defects on apples by using Pattern matching, segmentation, sorting, and Baye's theorem. Based on shape, fruits are separated into three classes for grading this system. All images are segmented on the basis of the Bays theorem. By using these techniques the rate of accuracy will be in 73%. In this paper, finding accuracy and wavelength bands are used.

R.Swamy narayanan, et.al (2005) has proposed classifying the various fruits like apple, dates, blueberry, and pomegranate etc. Digital image processing along with classification and neural network algorithms has enabled grading of various fruits. Grading and sorting system allows the maintenance of the consistency, uniformity and depletion of time. In this paper, efficient and accurate algorithms have been produced for grading various fruits and impurities, but the speed of process is still failed to meet modern manufacturing requirements in order to satisfy this situation where optimized algorithms are used

Yankun peng, (2006) et.al has proposed to determining the maturity by using firmness prediction. Scattering analysis method is used to determine the firmness of the apple in order to reduce the noise signal from the the scattering images. The apple firmness is commonly measured with the magness-Taylor (MT), firmness tester. This MT measurement is only suitable for sampling purposes and cannot be used for grading fruits.

A.Rajabipour, et.al. (2007) has proposed grading the fruits based upon its shape. Also misshapen fruits are usually rejected according to grading standards of fruit. Some of the physical characteristics also to be measured such as mass, dimension, volume, density, spherical coefficient. The sophisticated equipment is not needed. It requires only the aspect ratio, it is used to detect the flattened fruit.

Mohamed Sharif, et.al. (2008) has proposed the grading of oil palm fruits by using colour models. The colours namely red, green and blue (RGB) of the palm oil fruit bunch were investigated using this grading system. This grading system was developed to distinguish the three different categories of oil palm fruit bunches based on RGB intensity.

M.Naderiboldaji, et.al. (2008) has proposed predicting the mass of apricot fruits. The apricot mass was predicted by different physical characteristics with linear and non-linear models as three different classifications such as dimensional characteristics, apricot projected areas and apricot mass based on its volume. These properties were determined at the specific fruit moisture contents of shams (84.87%), nakhjavan (87.88%) and jahangiri (81.73%) cultivars respectively.

Joseblasco, et.al. (2010) has proposed the detection of defects during the post-harvest quality inspection of citrus using multivariate image analysis approach. This analysis is used to extract a reference Eigen space from a matrix built by unfolding colour and spatial data from samples of defect free peel. The success ratio for the detection of defects was 91.5%. while the classification ratio of damaged samples was 94.2%.

Arivazhagan, et.al. (2010) has proposed the efficient fusion of colour and texture features for fruit recognition. This is done by the minimum distance classifier based on the statistical and co-occurrence features derived from the wavelet transformed sub bands. This method has provided 95% accuracy. But the variability of the agricultural objects made it very difficult to adapt the existing industrial algorithms to the agricultural domain. Increasing the number of images in the database can increase the recognition rate too. To get 100% accuracy, it needs size and shape features.

Weixing Zhu , et.al. (2011) has proposed the grading apples based on its feature i.e., fusion of size, shape and colour. In this paper, Background Propagation (BP) neural network and Dempster Shafer (D-S) evidential theory has to improve the accuracy of the grading of apples. BP network classifier is used to construct the basic probability assignment (BPA) by combining the classifiers outputs. Finally, D-S fusion has to be used to achieve the final grading result. It has much higher grading than single feature extraction.

Yasushikohno,et.al.(2011)has proposed the mobile grading machine for citrus fruits which has been developed to collect crop information such as fruit yield, diameter and sugar content of fruits. These types of maps indicate that a lot of information about yield and quality of each citrus tree is visualized simply and also has to be used to reduce processing speed.

Hadi Seyedarabi, et.al. (2013) has proposed sorting of date fruits based on different stages of maturity, namely khalal, rotab and tamar. Physical and mechanical features were extracted from the samples provided and the detection of algorithm was designed accordingly. The performance of the proposed system was satisfactory in terms of sorting tamar and khalal. But an accuracy of the system for the detection of rotab was insufficient.

S.Al-Rahbi, et.al. (2013) has proposed to detecting the surface crack of the date fruits. Three grades of dates such as no-crack, low crack and high crack dates were obtained. Some features were extracted from each image and used in the classification models. The classification accuracy was supposed to be 62%, 58% and 78% for high crack, low crack and no-crack respectively using linear discriminant analysis (LDA).

III. OBSERVATION

From the literature survey, it is clearly noted that the following methods (table 1) are used by different research persons for grading the fruit maturity.

1. Hue saturation intensity (HSI) model is used for find the colour features.
2. Wavelet transform is used for segmentation purpose. This method is also used for background subtraction from the fruit.
3. Linear discriminant analysis (LDA) is used to detect the crack on the fruits.
4. Modified lorentzian distribution (MLD) is used to predict the fruit firmness.
5. Multi variant analysis is used for the detection of defects during the post-harvest quality inspection of fruits.
6. Multi-feature fusion method is used for yielding higher grading rate than single feature method in grading system.
7. Fourier transform is used to specify the size and shape.
8. Co-occurrence technique is used to extract features such as contrast, energy and homogeneity.
9. Pseudo cylindrical projection is used to contour detection for area measurement.
10. Mean colour intensity and area algorithm are suitable for separating the mature and over mature category.

Table 1.Different techniques for maturity analysis

s.n	**Technique**	**Inference**
1	Mean colour intensity, area algorithm	• Accuracy better • It is not suitable for distinguish mature and over mature fruit
2	HSV mask method, Threshold method	• Less expensive • Miss prediction on surface cracks of date fruits
3	Morphological technique	• Automatic grading system • This technique provides low noise • High cost experimental setup
4	Correlation technique, HSI Color models	• Easy to find ripe fruit • It requires correct RGB intensity value for finding fruit maturity
5	Wavelet transform, HSV Color models	• It provide a better accuracy on fruit grading

Research possibilities

Various techniques are used in extraction of colour feature in fruits such as dominant method and intensity distribution method for finding the fruit maturity. These are the well characterized methods in terms of morphological process and the other segmentation is to provide the fruit maturity.

- For high accuracy detection rate wavelet filter can be used before applying wavelet transform segmentation.
- To increase the speed to speed up the process, the training of deep neural network (DNN) could be used.
- In future, the grading system can be connected to make it available for users to test the ripeness of their fruit online.

IV. CONCLUSION

In this paper, various grading techniques were studied for fruit maturity. In this study, different methodology has been used for segmentation and classifications were reviewed. Advantages of different methods are combined to improve the better accuracy rate and to provide a low error in the classification of different maturity stages.

Works proposed by the researchers were extended for the development of k-means clustering such as wavelet transform and multi svm in order to increase the accuracy and grading the rate of final classification process.

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