Image Processing System for Automatic Segmentation and Yield Prediction of Fruits using Open CV

T. GAYATHRI DEVI [1], DR. P. NEELAMEGAM [2], S. SUDHA[3]

[1]Assistant professor, ECE, School of EEE, SRC, SASTRA University,
[2]Professor, E&I, School of EEE, SASTRA University,
[3]Assistant professor, ECE, School of EEE, SRC, SASTRA University,

Abstract - In fruit harvesting systems, automatic yield counting of fruits becomes a big issue. Image processing techniques minimizes the manual task of recognizing and counting the fruits. In this paper, an image processing system for automatic segmentation and yield prediction of fruits is proposed on the basis of color and shape features is being performed. Initially the preprocessing is done on input fruit tree images. Then it is converted from RGB to HSV color space to detect the fruit region from its background. Color thresholding is used to mask the desired colors. Gaussian filter is used to remove noise. The contour of the image is taken. Then these images are processed by image processing algorithm. Color and shape based counting of fruit is presented at the output. The edge detection and combination of a circular fitting algorithm is applied for the automatic segmentation and automatic counting of fruits in the image. Different types of fruits (orange/tangerine, pomegranate, apple ,lemon, mango,cherry) are used for automatic counting. Open CV Python software is used to perform the required image processing operations.

Keywords: Edge detection, Circular fitting, Image processing, HSV color space, color thresholding

I. INTRODUCTION

Automatic counting of fruits in practical environment is the major issue in crop management and fruit harvesting system to increase the productivity with moderate cost. There are various types of algorithms used for automatic segmentation and counting of objects in an image. To automate this segmentation and counting process, [1] different techniques are proposed, which utilized the intensity, color, orientation and edge feature vectors of the acquired image [2]. The image processing applications were developed instead of man power who failed to recognize and count the objects from the input images. It begins with recognition of fruits with different colors [3] brings the hybrid method of combining the texture and color features. This method is implemented to recognize the red and green color apples. The spherical shape fruits are identified by the combination of different novel methods [4] with many problems. The identification of orange fruit using the machine vision algorithm is described and includes of region labeling, perimeter extraction, segmentation, size filtering and perimeter based segmentation [5]. Various fruit identification processes are analyzed and a new automated fruit recognition system [6] is developed where the segmentation is based on the shape based analysis and is capable of identifying the fruits at different maturity level. First the acquired input image is preprocessed and the existing noises are removed. Then from the input image , the background is suppressed by the Graph Cut Algorithm [7] . The HSV is extracted from the foreground RGB color space from for the successive steps [8]. Color thresholding [9] is used for the segmentation process of the foreground images . This color thresholding is used to mask the desired color on the image. Connected Component Labeling (CCL) is used for the object recognition[10] and Canny Edge detection method is used to detect the edges of the identified fruits [11]. At last the Circular Fitting Algorithm [12] is used to identify those strong edges and makes the object to fit into a circle. This method leads the counting process made easy. The number of circles occurs in the processed input image is the number of fruits. The combination of color image segmentation and the fuzzy logic technique [13] is used for detecting the ripeness stage of the fruit without seeing and touching and in paper [14] &[15] the author identified the fruit features based on fruit size detection and system. The fruit features are extracted by detection algorithms. In paper[16],the author described conventional RGB camera with making use of machine learning technique to detect immature, mature, and young fruits on the plant.

978-1-5386-3243-7/17/$31.00 ©2017 IEEE

II. PROPOSED SYSTEM

The proposed method has the following steps

- Step1: segmenting the fruit by color and shape analysis.
- Step 2: Color analysis is done by using color thresholding.
- Step 3: Shape analysis is done by finding contour and connected components.

In this process, segmentation of fruits is achieved using OpenCV python with more than 98% accuracy.

The fig.1 depicts the work flow of the proposed fruit counting system.

A. Block diagram

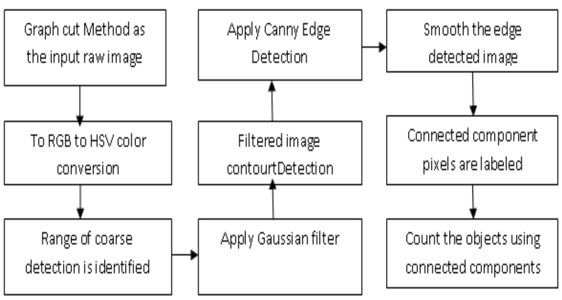

Fig.1 Flow Diagram of the proposed system

B. Image capturing and Graph cut method.

The input image is captured and then preprocessed. Graph cut method is used to suppress the Background from the captured image,which uses the conventional inbuilt steps to extract the foreground portion with the user defined image area. The fig.2 and fig.3 shows the input and graph cut image.

Fig.2 Input image

Fig.3 Graph cut image

C. Color conversion

The next step is color conversion from RGB to HSV color space.To extract the HSV value the forground mage is taken.The images are usually in the RGB color space which is difficult for human description of color, highly redundant, correlated Hence it is important to transform the RGB color space of the original foreground extracted image into the HSV color space image which changes the saturation and hue value of the image [8]. The HSV is capable of decomposing the image into several meaningful parts which are used for the segmentation process.The fig.4.shows the RGB to HSV converted image

D. Detection of Fruit

From the HSV color spaced image the fruit region has to be extracted by using color thresholding. This is done by identifying the range for coarse detection of fruit depending on the color of the fruit image which is taken for processing. It separates only the fruit region in the image. Range includes minimum and maximum value of HSV color space. The extraction of fruits based on the color is also called as 'color thresholding'. The segmented image is shown in fig.5

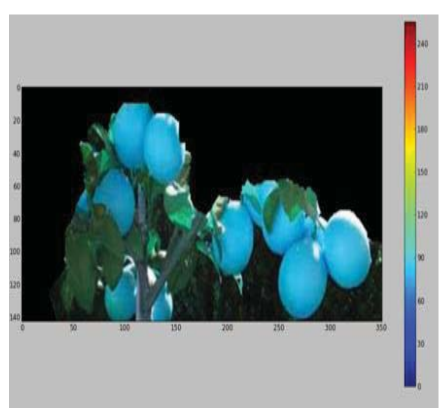

Fig.4 HSV image

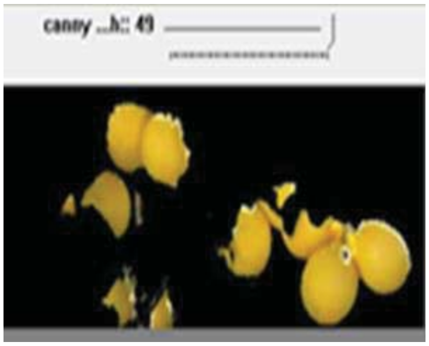

Fig.5 Segmented Image

E. Canny Edge Detection

Canny Edge Detection Algorithm is one of the ideal edge detection techniques with strong localization and clear response. The Canny edge detection method is a group of four inbuilt process such as smoothing, gradients computation, Non-Maximum Suppression and thresholding. The output of the final thresholding step gives the optimal edges of the extracted objects in the image. Though the image is preprocessed in the beginning stage, after the object extraction stage the existing noises may spoil the image.And hence the Gaussian filter is used to de-noise the image. Finally the detected strong edges are collected and marked in the image to display the contour of the objects in the image. This is shown in Fig.6

F.. Connected Component Labeling

Region Labeling is a processof extracting the object region using the connected components and is correlated to the image.The Connected Component Labeling normally recognizes the groups and labels of connected pixels. The images after thresholding are taken for the object extraction process. If the pixels are connected vertically or horizontally or diagonally, then the pixels are considered to be connected. This process can also be related for high dimensionality data or image.The fruit can be filtered, counted or even tracked using region labeling which is done by blob extraction process. This is shown in fig .7

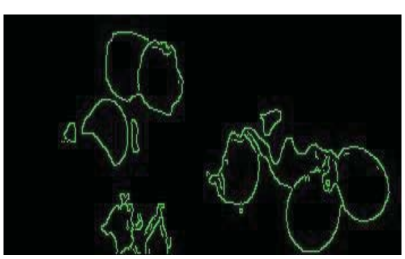

Fig.6 Canny Edge Detection

Fig.7 Connected components image

G Fruit Counting Using Circular Fitting Algorithm

The automatic counting of fruits is implemented using the Circular Fitting Algorithm where identified strong edges are allowed to fit in a circle. Finally the number of fruits is calculated by counting the fitted circles on the input image which makes the process of fruit counting automatic.

H. Yield estimation and quality Parameter

Shape analysis concept is utilized for the process of yield measurement which detects the total number of fruits in a tree with minimized time. The mean yield estimated error is determined by the quality parameters. Percentage accuracy and mean absolute percentage error (MAPE) are quality parameters which are defined as

$$\%ofaccuracy = \frac{\mathrm{Alg}\,orithamicallycount}{Manualcount} X100\% \tag{1}$$

The mean absolute Percentage error

$$MAPE = \frac{1}{N}\frac{|Mi - Ai|}{|Ai|} X100\% \tag{2}$$

Here, N – total number of fruits,

i= 1 to N,M- Manual counting, A- Algorithmic count

III RESULTS AND DISCUSSIONS

Various types of fruits are identified and counted using the proposed system such as cherry, orange, lemon, pomegranate and mango.

Table1 and Table 2 gives the information about the comparison between the manual counting and algorithmic counting by using the shape and colour analysis and also the comparison between the manual counting and algorithmic counting by using the contouring respectively. Accuracy also provides in the table.

Fruit	Color	Manual counting	Algorithmic counting	Accuracy
Cherry	Red	8	8	100
Mango	Yellow	2	2	100
Orange1/tangerine	Orange	9	8	88.88
Apple 2	Red	3	3	100
Pomegranate	Red	3	3	100
Orange2/Tangerine	Orange	18	17	94.44
Orange3/Tangerine	Orange	12	10	83.33
Lemon 1	Yellow	14	13	92
Lemon 2	Yellow	3	3	100

TABLE1. COMPARISON BETWEEN THE MANUAL COUNTING AND ALGORITHMIC COUNTING BY USING THE SHAPE AND COLOUR ANALYSIS.

Fruit	Color	Manual counting	Algorithmic counting	Accuracy
Cherry	Red	8	8	87.5
Mango	Yellow	2	2	30.33
Orange1/tangerine	Orange	9	8	50.55
Apple 2	Red	3	3	30.33
Pomegranate	Red	3	3	66.66
Orange2/Tangerine	Orange	18	17	61.66
Orange3/Tangerine	Orange	12	10	75
Lemon 1	Yellow	14	13	57.14
Lemon 2	Yellow	3	3	100
Orange4/Tangerine	Orange	5	3	80

TABLE.2 COMPARISON BETWEEN THE MANUAL COUNTING AND ALGORITHMIC COUNTING BY USING THE CONTOURING.

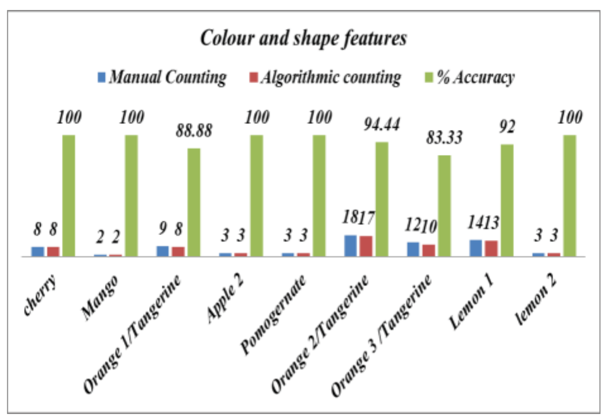

Fig. 8 Comparison Chart

The fig.8 and Fig. 9 shows the comparison in terms of graph. This figure depicts that the proposed image processing system detect the fruits better than the manual counting and gives better accuracy. And hence this proposed method of colour and shape feature providing better accuracy than the contour feature.

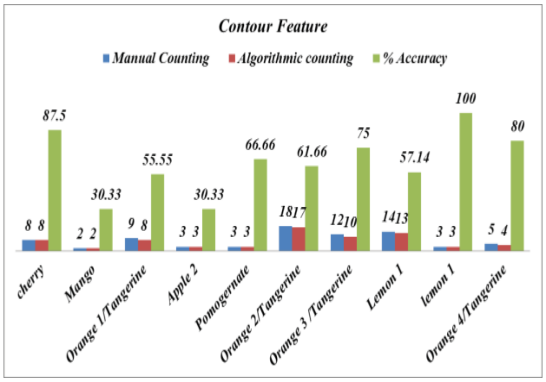

Fig 9: Comparison Chart

IV CONCLUSION

In this paper an image processing system is developed for the yield prediction of fruits. The proposed method composes of various steps and they are edge detection, connected region labeling and finally circle fitting based detect. At the first, The proposed algorithm can be improved to design an automatic crop health monitoring in future. Segmentation of fruits is achieved using OpenCV python with more than 98% accuracy. In addition, this proposed system reduces the cost spend on the manual process of counting the fruits and also reduces the false estimation. The implemented results are discussed and compared to the manual counting process.

References

[1] Patel Hetal, Jain R.K and Joshi M.V, “Fruit Detection using improved multiple feature based algorithm”, International Journal on Computer Applications, Vol-13, No-2, pp. 1-5, ISSN: 0975 – 8887, January, 2011.

[2] SyalGarg and S. Sharma, “A Survey of Computer vision methods for Counting Fruits and Yield Prediction”, Volume 2, pp.2319-7323, 2013

[3] ArivazhaganS, NewlinShebiah R, NidhyanandhanSelvaS, GanesanL, “Fruit Recognition using Color and Texture Features”, Journal of Emerging Trends in Computing and Information Sciences, Volume 1, no. 2, Pages: 90-94, Oct 2010.

[4] Zhao,J.T.,J.Katupitiya,J.,“On-treefruitrecognition using texture properties and colordata”,International conferenceonIntelligentRobotsandSystems,pp.263-268,2005.

[5]HannanM.W.,BurksT.F.,BulanonD.M.,“A machineVision Algorithm for OrangeFruit Segmentation”, Agricultural EngineeringInternational:the CIGRE journal, Volume 11, Pages: 1-7,December-2000

[6]JimenezR.,JainA.K.,CeresR.,PonsJ.L.,“Automaticfruitrecognition:A surveyandnewresultsusing Range/Attenuation images”,Pattern Recognition, Volume 32, Issue 10, pp.1719-1736, 1999.

[7] Sara Vicente, Vladimir Kolmogorov and CarstenRother, “Graph cut based image segmentation with connectivity priors”, IEEE International Conference on Computer Vision and Pattern Recognition, ISBN: 4244-2242, pp. 1-8, June 2008.

[8] SimardeepKaur and Vijay Kumar Banga, “Content Based Image Retrieval: Survey and Comparison between RGB and HSV model”, International Journal of Engineering Trends and Technology ,Volume 4, Issue 4, April 2013.

[9] NilimaKulkarni, “Color Thresholding Method for Image Segmentation of Natural Images”, International Journal of Image, Graphics and Signal Processing, Volume 1, pp.28-34, Feb 2012.

[10] G. Gayathri Devi and C. P. Sumathi, “Positional Connected Component Labeling Algorithm”, Indian Journal of Science and Technology, Volume 7, Issue 3, pp-306-311, ISSN: 0974-6846, March 2014.

[11] Rashmi, Mukesh Kumar and RohiniSaxena, “Algorithm And Technique on Various Edge Detection: A Survey”, International Journal on Signal and Image Processing, Volume 4, Issue 3, June 2013.

[12] H. N. Patel, R.K.Jain and M.V.Joshi, “Automatic Segmentation and Yield Measurement of Fruit using Shape Analysis”, International Journal of Computer Applications, Volume 45, Issue 7, ISSN: 0975-8887, May 2012.

[13] MeenuDadwal and V.K.Banga, “Estimate Ripeness Level of fruits Using RGB Color Space and Fuzzy Logic Technique”, International Journal of Engineering and Advanced Technology, Volume 2, Issue 1, ISSN: 2249-8958, Oct 2012.

[14] RashmiPandey, SapanNaik and Roma Marfatia, “Image Processing and Machine Learning for Automated Fruit Grading System: A Technical Review”, International Journal of Computer Applications (0975 – 8887) Volume 81 – No 16, November 2013.

[15] RupaliS.Jadhav, S.S.Patil, “A Fruit Quality Management System Based on Image Processing”, Journal of Electronics and Communication Engineering (IOSR), .Vol. 8, Issue 6, PP 01-05, 2013.

[16] Kyosuke Yamamoto, Wei Guo , Yosuke Yoshioka, Seishi Ninomiya , “On Plant Detection of Intact Tomato Fruits Using Image Analysis and Machine Learning Methods”, Sensors No.14, 2014.