March - April 2020
ISSN: 0193-4120 Page No. 8791 - 8796

Estimation of Tomato Berries based on Image Segmentation in RGB Color Model

[1] D.Bini, [2]D.Pamela , [3]Shajin Prince

[1] Research Scholar, [2]Associate Professor, [3]Assistant Professor

[1,3] Department of Electronics and Instrumentation Engineering

[2]Department of Biomedical Engineering

[1,2,3] Karunya Institute of Technology and Sciences

Article Info
Volume 83
Page Number: 8791 - 8796
Publication Issue:
March - April 2020

Abstract

Estimating crop yield accurately remains important in dealing a farming enterprise successfully, enabling decisions concerning crop management, estimated delivery intervals and measures to consumers and creates a rating, to code but a little. Until ages, yield estimation is based on projections from labor-intensive counting and proportions of selected plants which are difficult in forecasting and management. In this paper, a method has been urbanized for precise estimation of a tomato plant by using color thresholding in MATLAB by means of RGB color model. The modules involved for the detection of red color in a captured image are the conversion of RGB image into gray scale image. A two-dimension black and white image is obtained by subtracting the two images and then a median filter is used to filter the noisy pixels. The binary digital images are labelled to identify connected components using bounding boxes and the metrics of the labelled regions are calculated for the counting number of tomatoes in a plant. Added, by analyzing RGB values for individual pixels in the captured image, the color of the individual pixels is renowned. The proposed prototype exhibited high aptitude in estimation of yield for each tomato crop.

Article History
Article Received: *24 July 2019*
Revised: *12 September 2019*
Accepted: *15 February 2020*
Publication: *09April 2020*

Keywords: *Color Image, RGB color space, Image processing, blob analysis, tomato crop yield estimation.*

I. INTRODUCTION

Estimation of crop yield is an essential assignment in the agricultural industry. Agriculture is the prime source of revenue for more than 45% of the population of Tamil Nadu, India. Tamil Nadu has engaged an area of around 63 Lakh Ha for plantation out of 1.3 lakh sq.km its total area of the state. The State Department of Agriculture emphasis on stabilizing food scraps production accordingly to make sure food and nourishment security. Accurate prediction of crop yield provides growers to increase the quality and to ease the operating cost by creating better choices on intensity of yield and proportions of the yield labor power. The Crop Cutting Experiment is supported in the states for crop yield estimation of various crops under a scheme adopting technical methodology.

Cropland productivity, categorized through crop harvests, remains determined by means of soil, climatic circumstances, crop types accompanied by their related phenological phases[1]. Defined yield estimation is accomplished on the basis of historical statistics and workers physically counting the yield of a crop in multiple sampling sites[2]. An extensively implemented solution for crop yield estimation is to practice computer vision for detection and calculating of yields[3].To detect the fruit areas from the image, a Fast Normalized Cross Correlation (FNCC) was used based on machine vision process considering the parameters, counting colour, contour and texture. A template matching technique removed false positives and Circular Hough Transform aided the detection of circles from the images [4].

TEST Engineering & Management
March - April 2020
ISSN: 0193-4120 Page No. 8791 - 8796

Eigenfruit tactic with a shifting sub-window expending intensity and saturation components along with circular Gabor texture conceded on for green citrus recognition [5]. Automatic recognition of apple fruits with machine vision arrangement using Charge Coupled Device camera and was designed for robotic harvesting. The fruit image was enriched with red colour as the fruit obligated highest red colour in the spitting image. The optimal threshold was determined by the intensity histogram of colour difference between red coloured apple and the background [6]. In the same way, for an apple detection procedure, the RGB model was developed with a difference of G-R and R-B [7].

Color detection forms the ultimate stage for a machine vision algorithm. An image is a representation of matrix with pixel denominations and various color models like RGB, gray-scale and HSV. The 3-dimensional RGB image is converted to a gray scale image and is subtracted to obtain a 2-dimensional image in black and white. The binary digitized regions are calculated by labelling with bounding boxes [8]. Edge detection can be used for pattern recognition and image retrieval by forming boundary among the object and background [9]. Image segmentation encompasses the credentials of regions of concern of an object from a digital image. HSV converted image along with tonality segmentation algorithm and pixel segmentation in homogeneous regions performed for object tracking [9]. Using RGB and HSV models, an unsupervised image segmentation method which advances split, region growing and merge methods, outperformed with shorter processing time [10]. To regulate the optimum number of masses, Bayesian Information Criterion (BIC) was controlled along with maximization, k-means and Self-organizing map (SOM) algorithms to differentiate the berry and the background pixels [11].

In this paper, a proposal is formulated for yield estimation of tomato berries with image segmentation techniques. The tomato berry has a change in color from green to amber and then red with an ellipsoidal or an oval shape during the time of harvest. The performance of segmentation methods is analyzed in order to calibrate the estimation of tomato yield.

II. MATERIALS PROVISION AND METHODS

2.1 Framework of the proposed Algorithm

The crop yield estimation implemented by analyzing images with high resolution real time RGB model. For the tomato yield estimation, the best segmentation technique analyzed was optimum thresholding operated in H layer. The real time pictures of a tomato plant without overlapping amongst sequential images were captured. The captured images needed resizing for the ease of computational access. Resizing of images was executed through bicubic method to achieve best results. The bicubic method minimizes spikiness of the image thereby changing the pixels of the image. The resized image is prone to different noise which suppresses the true strengths of the real time scenario. To remove the outlier noise without destroying the sharpness in the image, median filtering was implemented. The RGB components from the image are now extracted to form 3 varied 2-D matrices. Then convert the RGB pixels to gray-level image by emerging a weighted sum of R, G, and B components. The grayscale image is now converted to a binary image, where the input image through luminance larger than level is assigned value 0 and the background pixels with value 1.

The binary image obtained is now exercised for counting the number of berries using blob counting method. While binarisation, the fruit cluster may be grouped under same region leading to an error in counting number of fruits. The proposed analysis computed individual berries fast. The regions with cluster of berries are counted by extracting the fruit with Laplacian-Gaussian algorithm of segmentation. The image processing techniques are directed for an image proceeding with counting of number of tomatoes. The estimation results are saved in a database and are presented in a display interfaced.

March - April 2020
ISSN: 0193-4120 Page No. 8791 - 8796

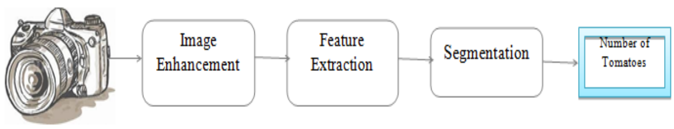


Figure 1: Framework of Image Processing Algorithm

2.2 Acquisition of Images

The images were gathered from tomato field arranged in rows with an ideal spacing of 75 cm X 45 cm under an average recurrent temperature range of about 16℃ - 25℃. The tomato plant was maintained with bright sunlight during the fruit set period so as to develop dark red berries. The characteristic properties of ripe berries are generally medium sized, round shaped and reddish in color. A classic digital camera with high-level resolution of 24.2 MP was used to acquire images in a natural daylight during the harvesting phase. The images captured were saved in JPG format with a high-level resolution of 4762 X 3168 pixels within the RGB color model. For ease of computational accessibility, the captured images were resized to 1000 X 800 pixels. The tomato plant images were captured in a sequence so that the samples do not overlap the consecutive images. Various image segmentation techniques were investigated for image processing and counting the number of yield.

2.3 Enhancement of Images

The most difficult and essential tasks in processing of images is segmentation where the desired objects get extracted from the image. Segmentation techniques continue to be availed for the abstraction of contours, regions and boundary of an image [18] & [19]. Binary or gray-level thresholding remains the modest technique in image segmentation. Thresholding for same shades of color fails to distinguish leaf and citrus fruits with its background as the features were unimodal [12]. In this paper, segmentation processeased in recognizing the tomato berry from the tomato plant as well as its background. The algorithm progressed with MATLAB R2014a software. The required time for processing the image was determined by the size of the image. As the captured image was with larger size, the processing was time-consuming and so the images were resized afore the segmentation process. The resized RGB image is amended to gray image and prerequisites filtration of noise.

To spotlight certain attributes and to neutralize the noise, filtering techniques are used. The wiener filter counteract with the Gaussian white noise of the gray scale image. The filter diminishes the mean square inaccuracies generated among the desired process and the random process estimated.

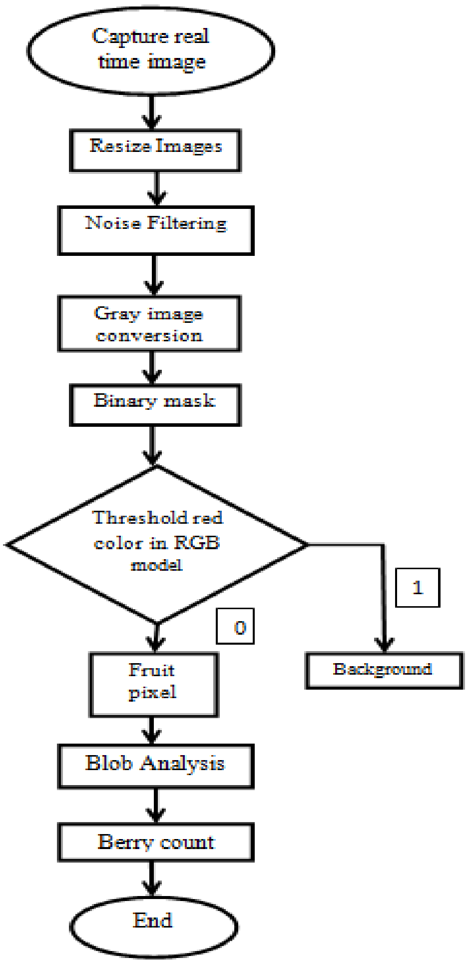


Figure 2: Flowchart of tomato yield estimation algorithm

2.4 Feature Extraction

The ripen tomatoes in the real time image can be extricated from the background pixels through meticulous properties. For segmentation as well as

TEST Engineering & Management

March - April 2020
ISSN: 0193-4120 Page No. 8791 - 8796

classification of the image, the features are assessed for every pixel. The extraction of relevant pixels will help to determine the image features for parting the foreground and background layers based on color thresholding. For a multispectral image, each pixel is designated with R, G, B magnitude within a selected range each. The RGB color model is an additive color space of three primary chromaticities in a 3D cubical Cartesian coordinate system.

2.5 Background Elimination

The berry and background pixels in RGB color space distributions are investigated for pixels within the range of the berry thereby discarding all the other pixels as background. To determine the threshold value t(x,y),

$$t(x,y) = \begin{cases} 0, f(x,y) < T \\ 1, f(x,y) \geq T \end{cases} \quad (1)$$

Where f(x,y) = original value of pixel,

T = threshold value.

As the ripen tomato berries represent the red region, a threshold for red color is computed and the berries are cropped from the background pixels. The background of the image embraces with green tomatoes, leaves and branches. In the RGB model of the image, the red ripen tomatoes were extracted by applying a threshold parameter, thereby removing the background as given in (1) and (2).

$$R > G \ \& \ R > B \quad (2)$$

The tomato berries get segmented from the background with some generated noise. The filtering techniques are applied to remove noise and erosion of the obsolete pixels at the boundaries. For the erosion technique, the output depends on the neighborhood of the input pixel as well as on the indiscriminate size and shape.

2.6 Berry Counting algorithm

The estimation of tomatoes is defined with the pixel values connected in a miscellaneous pattern. The berry pattern may station as individual fruit, two or three berries in cluster and some may partway occluded by leaves. The ripen berries are precisely recognized with the perceptible color difference among the leaf and berry as well as with their middling size. The erosion technique assisted the counting of clustered berries by crumbling out the undesirable neighboring pixels. The overlapping of berries made false counting in some instances as the thresholding of red pixels were challenging and formulated as under-estimation.

III. EXPERIMENTAL RESULTS

Figure 3 shows the crop yield estimation results for three distinctive tomato crops, assessed by thresholding techniques. Figure 3(a) shows the real time image of the tomato crop. In Figure 3(b) and (c) the images are resized, threshold the red berries for tomato identification. Then binary mask the berries and erode the neighboring pixels for overlapping. The blob analysis counts the pixels identified as berries and the tomatoes are labelled in Figure 3(d). The proposed method affords a high potential in estimation measure of the crop yield during the phase of harvest.

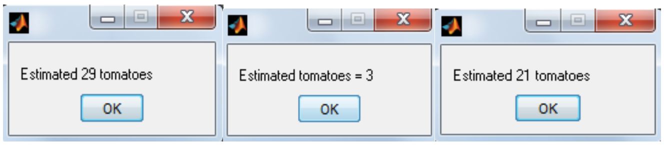
(a)

(b)

(c)

March - April 2020
ISSN: 0193-4120 Page No. 8791 - 8796

(d)



(e)

Figure 3: (a) Digital shots during the period of harvest (b) Thresholded the tomato berries by image processing technique (c) Binary and eroded Image (d) Labelled number of tomatoes by Blob analysis and (e) Estimated count of tomatoes

IV. CONCLUSIONS

The estimation algorithm for ripe tomatoes based on the RGB color features were progressed under diverse conditions. The images of bright red berries during the fruit set period were gathered during the natural daylight with a classic digital camera of high resolution 4762 X 3168. The images were captured in a sequence to preclude overlapping of consecutive images. The number of berries reviewed with the estimation algorithm closely correlated with the manual count of the crop yield. The algorithm will be appropriate for counting of fruits like peach, red apples and pears, cherries, red peppers and assorted red berries. The yield estimation by the proposed algorithm affords constructive report during planning of harvest and for insurance policies precision management.

REFERENCES

[1] Jiangui Liu, Ted Huffman, Jiali Shang, BudongQian, Taifeng Dong, Yinsu Zhang, Qi Jing, "Estimation of crop yield in regions with mixed crops using different cropland masks and time-series MODIS data", 2016 IEEE International Geoscience and Remote Sensing Symposium, Beijing, pp. 7161-7163.

[2] Qi Wang, Stephen Nuske, Marcel Bergerman, and Sanjiv Singh, 2013. "Automated crop yield estimation for apple orchards". Experimental robotics, STAR 88, pp. 745-758. DOI: 10.1007/978-3-319-00065-7_50, Springer International Publishing Switzerland.

[3] Swanson, M.Dima, C.Stentz, "A multi-modal system for yield prediction in citrus trees". ASABE (2010) Annual International Meeting, Pittsburgh, PA, United States, pp. 20-23, Paper number: 1009474.

[4] Han Li, Won Suk Lee, Ku Wang, 2016. "Immature green citrus fruit detection and counting based on fast normalized cross correlation (FNCC) using natural outdoor colour images". Precision Agriculture, DOI 10.1007/s11119-016-9443-z.vol.17, issue 6, pp. 678-697

[5] FerhatKurtulmus, Won Suk Lee, Ali Vardar, 2011. "Green citrus detection using 'eigenfruit', color and circular Gabor texture features under natural outdoor conditions", Computer and Electronics in Agriculture, pp.140-149. doi: 10.1016/j.compag.2011.07.001

[6] D.M.Bulanon, T.Kataoka, Y.Ota, T.Hiroma (2002), "A segmentation Algorithm for the automatic recognition of Fuji apples at harvest". Biosystems Engineering 83(4), 405-412. Doi:10.1006/bioe.2002.0132

[7] Rong Zhou, Lutz Damerow, Yurui Sun, Michael M.Blanke, 2012. "Using colour features of cv. 'Gala' apple fruits in an orchard in image processing to predict yield" Precision Agriculture 13:568-580, DOI 10.1007/s11119-01209269-2, Springer US-ISSN:1385-2256.

[8] VisheshGoel, SahilSinghal, Tarun Jain, Silica Kole, 2017. "Specific color detection in images using RGB modelling in MATLAB", International Journal of Computer Applications (0975-8887) vol. 161-No.8.

[9] SoumyaDutta and BidyutB.Chaudhuri,"A Color Edge Detection Algorithm in RGB Color Space," 2009 International Conferences on Advances in Recent Technologiess in Communication and Computing, Kottayam, Kerala,pp.337-340.doi:10.1109/ARCom.2009.72

[10] Gustavo Scheleyer, Claudio Cubillos, G.Lefranc, R.Osorio-Comparan and G.Millan, "A new colour image segmentation," 2016. 6th International Conference on Computers Communications and Control (ICCCC), Oradea, pp.232-239. doi: 10.1109/ICCCC.2016.7496766.

[11] J.Senthilnath, AkankshaDokania, ManasaKandukuri,Ramesh K.N., GauthamAnand, S.N.Omkar, "Detection of tomatoes using spectral-spatial methods in remotely sensed RGB images captured by UAV", 2016. Biosystems Engineering, vol 146, pages 16-32, https://doi.org/10.1016/j.biosystemseng.2015.12.003.

[12] Annamalai, P., Lee, W. S., & Burks, T. F. (2004). Colour vision system for estimating citrus yield in real-time. ASAE/CSAE Annual international meeting, paper number: 043054.

[13] Abraham Gastelum-Barrios, Rafael A. Borquez-Lopez, Enrique Rico-Garcia, Manuel Toledano-Ayala and GenaroM.Soto-Zarazua, 2011. "Tomato quality evaluation with image processing: A review", African Journal of Agricultural Research Vol.6(14), pp.3333-3339, doi: 10.5897/AJAR11.108.

[14] Yuanshen Zhao, Liang Gong, Bin Zhou, Yixiang Huang, Chengliang Liu, 2016."Detecting tomatoes in greenhouse scenes by combining AdaBoost classifier and colour analysis" in Biosystems Engineering 148(8):127-137, DOI: 10.1016/j.biosystemseng.2016.05.001.

[15] Zhao.J, Tow.J, Katupitiya.j, 2005. "On-tree fruit recognition using texture properties and color data," IEEE International Conference on Intelligent Robots and Systems, 263-268.

[16] Kane, K.E., Lee W.S., 2007. "Multispectral imaging for in-field green citrus identification," ASABE Paper No. 073025. St. Joseph, Mich.: ASABE.

[17] ArmanArefi, AsadModarresMotlagh, KavehMollazade and RahmanFarrokhiTeimourlou 2011, "Recognition and localization of ripen tomato based on machine vision," Austrian Journal of crop science, ISSN : 1835-2707, AJCS 5(10):1144-1149.

[18] Aiping Gong, Junlin Yu, Yong He, ZhenjuQiu 2012, " Citrus yield estimation based on images processed by an Android mobile phone," Biosystems EngineeringVolume 115, Issue 2, June 2013, Pages 162-170. https://doi.org/10.1016/j.biosystemseng.2013.03.009.

[19] Falah, R., Bolon, P., &Cocquerez, J. (1994). "A region and region edge cooperative approach to image segmentation". IEEE International Conference on Image Process, USA, 470-474.

[20] Ercal, F., Moganti, M., Stoecker, W., & Moss, R. (1993). Detection of skin tumor boundaries in colour images. Computer Journal of IEEE Transactions on Medical Imaging, 12, 132-141.