Betel Leaf Area Measurement Using Image Processing

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Abstract-

The deep green heart shaped leaves of betel vine are popularly known as a Paan in India. It is used in a number of traditional remedies. Now a day's customer's lifestyles and needs have gone through tremendous changes. These changes are new challenges for the farmers whose produce has to meet the customers demand. Concern to Betel producers the size and color of leaf is important factors to catcogrise the product in market.. This paper includes the area measurement method for Betel leaf based on image processing technique. The results are compared with the results of graphical area measurement technique. To evaluate image processing method and graphical methods known area object is used as reference. The experimentally it is proved that this method for measuring sugarcane leaf area is accurate with smallest relative error.

Key words: Image processing, Digital Photograph, Betel leaf, Leaf area.

I.   INTRODUCTION

The deep green heart shaped leaves of betel vine are popularly known as a Paan in India, which are consumed by about 15-20 million people in the country. There are about 100 varieties of betel vine in the world, of which about 40 are found in India and 30 in West Bengal. It is used in a number of traditional remedies for the treatment of stomach ailments, infections, and as a general tonic. It is often chewed in combination with the betel nut as a stimulatory. Some evidence suggests that betel leaves have immune boosting properties as well as anti cancer properties.

Betel is cultivated on about 55000 hector with an annual production worth about Rs 9000 million. These leaves are also in great demand in several other countries of the world .Consequently leaves worth about Rs 30-40 million are exported to the other countries, thus it is most promising commercial leafy crop capable of attracting substantial amount of foreign exchange to the country. Revenue generated would easily exceed if agronomic practices are scientifically explored [1].

Now a day's customer's lifestyles and needs have gone through tremendous changes. These changes are new challenges for the farmers whose products has to meet the customers demand. Betel leaf is a very perishable commodity and therefore always subject to wastage by quick spoilage due to dehydration, fungal infection, dechlorophyllation etc.so leaf area monitoring is an important tool in studying physiological features related to the growth, photosynthetic and transpiration process. Also being helpful parameter in evaluating, damage caused by leaf diseases and pastes, micronutrients deficiencies, water and environmental stress, need of fertilization, for effective management and treatment [2]

Leaf area determination can be done by direct methods, which involves the measuring of all the individual leaf areas or indirect methods, which are based on the relation of some plant characteristics with true leaf area obtained in destructive tests.

Precision agriculture production adapting rapid and accurate methods to measure plant leaf area. Present leaf area measuring methods are grid counting and paper weighing method, which are simple principals and high accuracy, but time consuming. Leaf area meter is high accuracy, but repetitions of readings are essential. The planimeter offers a less time consuming technique, but the precision is limited and high cost. Particularly in sugarcane leaf, size of midrib creates a problem in measuring by all these methods.

In leaf area measurement of coffee plants by using digital image analysis, they used two models, one based on the height and width of the canopies and other based on the area of digital image of a tree. Here the images were corrected by frequency histograms and for segmentation thresholding was done by Otsu method. The results were compared with real area of the leaves using digital scanner, they found 0.82 and 0.91 correlation. [2]. In other non destructive leaf area measurement they used Hough Transformation to acquire the coordinates of quadrangle corner points in distorted image and thresholding was used for image segmentation. To eliminate the effect of holes in the leaf, contour extraction approach was used where pixel scanning from one side to opposite side was implemented in four directions to extract contour and leaf area was measured by pixel number statistic. They found absolute error 2.88 [3]. In leaf area measurement of cucumber using image processing method they used reference object and picture pixel number statistic to calculate the leaf area ,found coefficient of variation of 3.99 [4]. In two new leaf area processed in Matlab and computer Aided software they found 99% accuracy [5]

In this technique, leaf area is determined by using digital photographs and Matlab tool to process the digital images. The results were compared with the results from grid counting method.

II. MATERIALS AND METHODS

A. Materials

Nikon Make 12.5 Megapixels Digital camera, PC, White Paper Sheet for background, One Rupees Coin as a reference Object, Matlab 7.4 version, Photographs of the leaves were arranged in number.

B. Methods

1. Graphical Method

Leaf, whose area to be measured was placed on the graph paper, having smallest grid size of 1 mm. Leaf is outlined with a pencil accurately and carefully on the graph paper. The total number of grids covered by outline edge of the leaf was calculated; consideration was, if edge outline occupied more than one half grids treated as one otherwise zero.

The number of grid count corresponds to the actual area of leaf.

2. Image Processing Method

The technique based on Matlab, is used for the image processing, is a semi automatic method to calculate leaf area and for more users this will be easy way to calculate leaf area. The code is written in Matlab version 7.4. This code will work in any higher version of the program.

Algorithm
1. Read the image.
2. Convert RGB to grayscale image.
3. Convert grayscale image to binary image.
4. Calculate the leaf area.

a.   *Photograph acquisition*

The leaf, whose area to be measured was placed on the white background with One Rupees coin, having 2.5 cm diameter, as a known area object. Leaf was placed as flat as possible and parallel to known object. The camera was held horizontally to the plane of the leaf. The photograph distance was neither too close nor too far; it was adjusted such a way that the photograph was covering only background, leaf and known object as shown in fig. 1

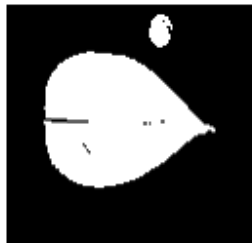Fig. 1 Betel Leaf with One Rupees Coin as a Reference Object

Fig. 2. Converting the color image to Gray Image

Fig. 3 Black and White Image

Number of pixels and Actual Dimensions

Leaf Pixel count = 3724

Leaf Area =123.45 cm^2

Fig. 4 Number of Pixels and Actual Dimension

b.   Determination of area

Photographs captured as shown in fig. 1 is processed by Matlab code in two colors. The function regionprops in Matlab was used to measure area of a selected region of an image in pixel count. Before applying the function regionprops, the actual image converted into a binary image as shown in fig. 2 and fig. 3.

Regionprops instruction is used to estimate area enclosed as shown in Fig. 4.The area is the actual number of pixels in the selected region.

The pixel count of the processed image depends on the distance between the camera and the object when the picture is taken. Smaller the distance, the larger the pixel counts. A reference object is an object with known area, needed to translate the pixel count area.

In this study, One Rupees coin is chosen as reference whose area is

$$\text{Area of coin} = \pi(d/2)^2, \text{ where "d" is diameter}$$
$$= \pi \left(\frac{2.5cm}{2}\right)^2$$
$$= 4.9063 \text{ cm}^2$$

The pixel count of the coin from the image is 148

Hence,

$$1 \text{ pixel value} = \text{Area of coin/ pixel count}$$
$$= 4.9063/148$$
$$= 0.03315 \text{ cm}^2$$

For Leaf, the pixel count of the area is 3724 pixels.

Hence,

$$\text{Area of Leaf} = \text{pixel count X 1 pixel value}$$
$$= 3724*0.03315$$
$$= 123.4506 \text{cm}^2$$

c.   Determination of Relative Error:-

Relative Error is calculated by the equation 1 as follow

$$Er = (Mc - M) / M \qquad\qquad (1)$$

Er is relative error, Mc is measure value; M is measure true value. Leaf area of grid counting is standard area and measure true value.

III.   RESULTS AND DISCUSSIONS:

To test the performance of the of new measurement system, leaves were selected from different plots and different varieties of Betel. Area of leaf calculated by square grid method considered as standard area. Table-1 lists the measurement results by standard method and proposed method with relative error. The Relative error can compare values and describe the accuracy of measure values. Relative errors of leaf area are calculated by equation (1).It indicates that the relative error value is smaller, the accuracy is higher. Relative error will increase if leaf has cuts due to insect bites, color patches due to diseases or different stresses.

TABLE 1. Comparison of Measured true value and measured value

Leaf No.	Actual Area (cm^2) Measured true value M	Area by New Method (cm^2) Measured value Mc	Error (Er)
1	44.24	44.64	0.008
2	44.48	44.95	0.010
3	55.13	55.49	0.006
4	136.18	123.45	0.093

With the implemented algorithm the relative error between area measurement by the proposed system and the actual values is typically 0.029 which is very less.

CONCLUSIONS

This work describes digital image processing techniques to calculate Betel leaf area, the implemented algorithm proved to adequate to compute the Betel leaf areas.

The grid counting techniques have very high accuracy, but take more time to measure leaf area. The image processing methods also have high precision and accuracy, it takes less processing time. Image can be processed at any time if only the images of the leaves have stored. This can provides the theory basis for developing hand-held leaf area meter to satisfy requirement of precision farming.

The relative errors seems to be varying because of plant diseases and insect pests, they will remove some area from the leaf or make the color of this area different from healthy leaf, results in pixel count that will less than the true pixel count of the selected region, this gives wrong area calculation. This component will be valuable and necessary to consider to achive accurate area calculation and estimatation of the diseases severity for application of pesticide and fertilizers.

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REFERENCES

[1]   Harsh Sexena, "Betel leaves – Basics and Economics in Indian   Scenerio",June 2009.
[2]   Morlon Marcon , Kleber Mariano (et.al),"Estimation of total leaf area in perennial plants using image analysis", R.Bras.Eng.Ambiental,2011,v.15,96-101.
[3]   Chaohul Lu,Hui Ren (et.al) "Leaf area measurement based on image processing,"IEEE,2010,580-582.
[4]   Tian You-wen,Wang Xiao-juan,"Analysis of leaf parameters measurement of cucumber based on image processing, "World congress on software engineering,2009,34-37.
[5]   Enrique Rico-Garcia, Fabiola Hernadez—Hernadez ," Two new methods for estimation of leaf area using digital photography, "International journal of agriculture and biology,"2009,397-400.
[6]   Hiroya Kondou,Hatuyoshi Kitamura,"Shape evaluation by digital camera for grape leaf."Science and Technology promotion center,2002,586-590.
[7]   Rafael C, Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB," Pearson Publication, 2008.
[8]   Jain A K, Image Analysis and Computer Vision. PHI, New Delhi,   1997.
[9]   Gonzalez R C., Woods E W, Digital Image Processing . International Students Edition ,Addison Wesley Longman, Inc. California (USA),1993.