LEAF DISEASE SEVERITY MEASUREMENT USING IMAGE PROCESSING

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Abstract-**Fungi-caused diseases in sugarcane are the most predominant diseases which appear as spots on the leaves. If not treated on time, causes the severe loss. Excessive use of pesticide for plant diseases treatment increases the cost and environmental pollution so their use must be minimized. This can be achieved by targeting the diseases places, with the appropriate quantity and concentration of pesticide by estimating disease severity using image processing technique. Simple threshold and Triangle thresholding methods are used to segment the leaf area and lesion region area respectively. Finally diseases are catcogrise by calculating the quotient of lesion area and leaf area. The accuracy of the experiment is found to be 98.60 %. Research indicates that this method to calculate leaf disease severity is fast and accurate.**

Key words- **Brown spot, Digital image, Disease severity, Image segmentation, Sugarcane leaf, Threshold.**

I.INTRODUCTION

Sugarcane being a long duration crop of 10 to 18 months, attacked by a number of diseases. Fungi-caused diseases in sugarcane are the most predominant diseases which appear as spots on the leaves. These spots prevent the vital process of photosynthesis to take place, hence to a large extent affects the growth and consequently the yield. In case of severe infection, the leaf becomes totally covered with spots. The various types of diseases on sugarcane determine the quality, quantity, and stability of yield. The diseases in sugarcane not only reduce the yield but also deteriorate of the variety and its withdrawal from cultivation.Excessive uses of pesticide for plant diseases treatment increases the danger of toxic residue level on agricultural products and has been identified as a major contributor to ground water contamination also pesticides are among the highest components in the production cost their use must be minimized. This can be achieved by estimating severity of disease and target the diseases places, with the appropriate quantity and concentration of pesticide.

The naked eye observation method is generally used to decide diseases severity in the production practice but results are subjective and it is not possible to measure the disease extent precisely. Grid counting method can be used to improve the accuracy but this method has cumbersome operation process and time consuming. Image processing technology in the agricultural research has made significant development. To recognize and classify sugarcane fungi disease an automated system has been implemented using algorithm such as chain code technique, bounding box method and moment analysis[1].To measure severity of Rust disease on Soybean, disease spot have segmented by Sobel operator to find out spot edge and plant disease severity has measured by calculating the quotient of disease spot area and leaf area[2].Earlier severity of attack of herbivorous insects on leaves have been calculated using video digitizer for pesticide application[3].Extent of color patches due to micronutrient deficiency or fungal disease on leaves have calculated by color thresholding method [4].In particular disease color as well as shape of leaves also changes that have measured by using HSV color space, Speeded Up Robust Features (SUFR), Scale Invariant and Feature Transformation (SIFT)[5].By choosing color difference due to fungal infection and lookup table it is possible to distinguish the healthy leaf area from diseased one[6].Disease severity can be measured in three different ways that are Visual Rating, Image Analysis and Hyper spectral Imaging[7].Using multispectral images thresholding operation Ratio of Infected Area (RIA), Lesion Color Index (LCI) and Severity Index of Soybean rust have been calculated[8].Similarly using reflectance value in the green and NIR regions, same time the SWIR domains, orange rust of sugarcane has detected[9].These spectral reflectance value is also useful to

determine chlorophyll index which is helpful for sugarcane infected plots detection and monitoring from Satellite imagery[10].Disease in wheat plant has detected in early stage using spectral reflectance of plant and neural network[11].Disease infection on fruits is also important to maintain the quality of the fruit, to increase the final yield. Many research have been conducted for the same as - classification of grape fruit peel disease have been done using color texture feature sets through a discriminate function with 2.3 % standard deviation[12].Classification of Citrus disease also carried out using feature and classification using neural network based back propagation algorithm[13]. In this research severity of brown spot disease is measured with the help of image processing technique. Brown spot causes reddish-brown to dark-brown spots on sugarcane leaves. The spots are oval in shape, often surrounded by a yellow halo and are equally visible on both sides of the leaf. The long axis of the spot is usually parallel to the midrib. The accuracy of the algorithm is tested by estimating the percentage standard known area covered by standard known area shapes like Triangle, Circle, Square, and Rectangle drawn by using a tool such as paint which comes as accessories of Microsoft Windows Operating System. Estimated values are compared with actual area covered to calculate Percentage Deviation (D) and Percentage Accuracy of the algorithm.

II. MATERIALS, PRINCIPLE AND METHOD

A. Materials

Brown spot infected Sugarcane leaves 90 samples, 12 Mega pixel Digital Camera, White paper sheet, Light System with 18 W cool light bulbs and light filters, PC, MATLAB 7.4 Version, Known area standard diagram drawn using paint brush.

B. Principle

Disease severity is the area (relative or absolute) of the sampling unit (leaf) showing symptoms of disease. It is most often expressed as a percentage or proportion [7]. The disease severity of the plant leaves is measured by the lesion area and leaf area ratio. Using image processing method it can be expressed as below

$$S = Ad / Al \qquad (1)$$

$$= P \sum_{(x,y) \in Rd} 1 \; / \; P \sum_{(x,y) \in Rl} 1$$

$$= \sum_{(x,y) \in Rd} 1 \; / \sum_{(x,y) \in Rl} 1$$

$$= Pd / Pl \qquad (2)$$

Where, S-Severity extent, P-Unit pixel value, Ad-Diseased leaf area , Al- Total leaf area, Rd- Diseased region, Rl-Leaf region, Pd-Total pixels in diseased area, Pl-Total pixels of leaf.

In the digital image every pixel represent the same size so ratio ‘S’ can be obtained by counting pixels of total leaf area and lesion leaf area in the binary image. Then according to disease category standard consult table the final severity level can be estimate.

C. Method

C.1 Image Acquisition:

Sugarcane brown spot diseased leaves are taken for this study. Images are taken in controlled environment and are stored in the JPEG format. Infected leaf is placed flat on a white background; Light sources are placed at 45 degree on each side of the leaf so as to eliminate any reflection and to get even light every where, thus a better view and brightness. The leaf is zoomed on so as to ensure that the picture taken contains only the leaf and white background.

C.2 Image Segmentation

Image segmentation is the important step to separate the different regions with special significance in the image, these regions do not intersect each other and each region should meet consistency conditions in specific regions [14,15]. In this study two different segmentation techniques are implemented to obtain total leaf pixels and lesion area leaf pixels.

C.2.1 Leaf region Segmentation

Input image is first converted into grayscale image. Since image is taken in controlled environment placing diseased leaf on the white background, it makes large difference in gray values of two groups, object and background. After image segmentation, the binary image containing leaf region is obtained by region filling and eliminating holes in the white region. To count the pixels in total leaf , scan the image from top to bottom and from left to right, the number of pixels in the region is Pl=140940.

C.2.2 Disease region segmentation

For success of experiment it is necessary to segment the disease region accurately. Segmentation may be wrong because of shallower midrib color than leaf color and fading of leaf color at early stages of illness. Also in different stages of the disease under the influence of light, water, neutrino the lesion manifest various symptoms, which bring difficulties to the segmentation. Based on the above factors, the image transformed from RGB color space to HSI color space, which is more suitable for visual characteristics of human beings. Since the brightness component is independent of the color component and the vision of the human being is more sensitive to Hue compared to Saturation, the color component can be good to eliminate glare, shadow and other light factors during color image segmentation. The similar gray value of the shallow color of the midrib and the leaf in color component can decrease the interference of the midrib in the follow up lesion image segmentation to a large extent. If the lesion characteristics are varied the boundaries between the lesion and the healthy part are also varies so there is weak edge. Hence triangle thresholding method is used here for selection of thresholding value of gray image.Fig.1 shows input color image. Fig2 Shows gray image. Histogram corresponding to gray image is as shown in fig. 3.To select the thresholding value, triangle is constructed by drawing a line between the maximum of the histogram at brightness bmax and the lowest value bmin in the image. The distance'd' between the line and the histogram h[b] is computed for all values of 'b' from b=bmin to bmax. The brightness value 'bo' where the distance between h [bo] and the line is maximum is the threshold value as shown in fig.3.

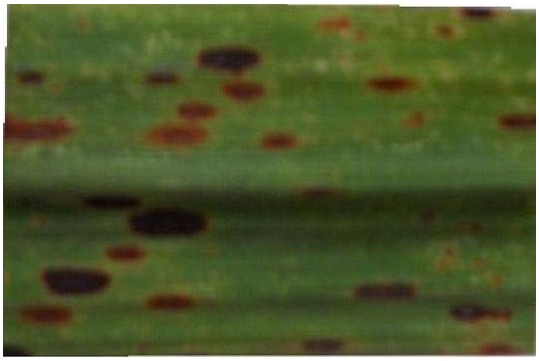

Fig.1 Brown spot diseased sugar cane leaf

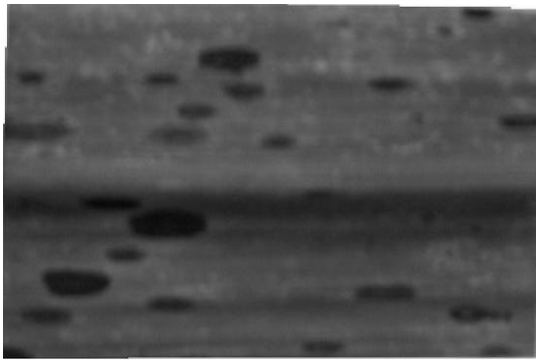

Fig.2 Grey scale image

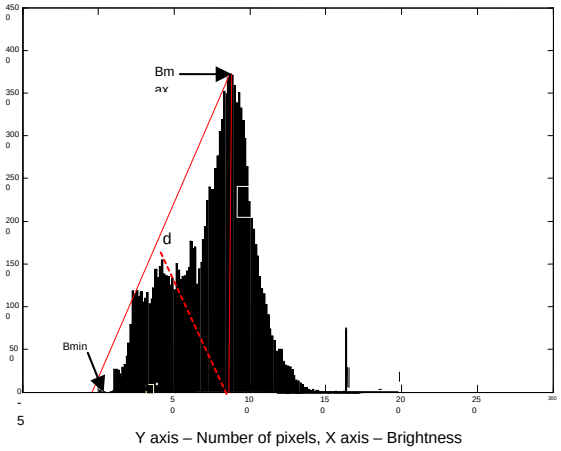

Fig.3 Histogram and calculation of Thresholding by Triangle method

The resultant binary image is as shown in fig.4 after scanning, the number of pixels in the white non zero region Pd=13401.Hence the ratio ‘S ‘of the lesion area and leaf area is 0.095.

Fig. 4 Lesion Region binary image

Thus according to table to assess diseases severity, developed by Horsfall and Heuberger, the diseases severity is of category 1.

TABLE 1
DIISEASE SEVERITY SCALE DEVELOPED BY HORSFALL AND HEUBERGER

Category	Severity
0	Apparently infected
1	0 – 25% leaf Area infected
2	26 – 50% leaf Area infected
3	51 – 75% leaf Area infected
4	>75% leaf Area infected

III EXPERIMENTATION AND DISCUSSIONS

The accuracy of the algorithm is tested by estimating the percentage standard known area covered by standard known area shapes like Triangle, Circle, Square, and Rectangle drawn by using a tool such as paint. Estimated values are compared with actual area covered to calculate Percentage Deviation (D) and Percentage Accuracy (A).

Where,

$$D= (SM – EM) \times 100 / SM \qquad (3)$$

$$A = 100 - D \quad (4)$$

SM- Standard Measurement, EM- Experimental Measurement

TABLE 2
DETERMINING THE ACCURACY OF THE ALGORITHM

Shape	Stand Measure (SM)	Expt Measure (EM)	Deviation (D)	Accuracy (A)
Triangle	2.49	2.45	1.61	98
Rectangle	0.90	0.90	0.00	100
Square	1.98	1.99	1.00	99
Circle	6.81	6.60	3.10	97
Group of All	12.19	12.42	1.87	99

The experiment proved that the algorithm developed has average accuracy is 98.60 %. The above data confirms the accuracy (validity) of the system for measurement of the disease severity.

IV CONCLUSION

Disease symptoms of the plant vary significantly under the different stages of the disease so to the accuracy with which the severity of the disease measured is depends upon segmentation of the image. Simple threshold segmentation is used to calculate the leaf area but this method is not suitable to calculate the area of the lesion region because of varying characteristics of the lesion region. Triangle method of the thresholding used here to segment the lesion region. The average accuracy of the experiment is 98.60 %.

Thus image processing technology to measure plant disease severity is convenient and accurate. This eliminates subjectivity of traditional methods and human induced errors. It will helps to farmers to decide the specific quantity for pesticide application which reduces the cost and environmental pollution.

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REFERENCE

[1] Sungkur R., Baichoo S. [at.el],''An automated system to recognize Fungi-caused diseases sugarcane leaves, "Research journal of University of Mauritius, 2009 pp.1-20.
[2] Shen Weizhong, Wu Yachun [at.el], "Grading method of leaf spot disease based on image processing,'' IEEE, 2008, pp.491-494.
[3] William W. Hargrave, D. A. Crosslacy," Video digitizer for the rapid measurement of leaf area lost due to Herbivorous insect", Journal of Entomological Society of America,1998,pp.591- 598.
[4] J. K. Jain, R.Rastogi,"Application of image processing in Biology and Agriculture," Nuclear India,1998,pp.12-13.
[5] Jennifer R. Aduwo, Ernest Mwebaze [at.el]," Automated vision based diagnosis of cassava mosaic diseases," Virus Research, 2004, pp.129-142.
[6] C.P. Wijekoon, G.H.Goodwin [at.el],"Quantifying fungal infection of plant leaves by digital image analysis using Scion Image Software," Elsevier, 2008,pp.94-101.
[7] H.Bock, G.H.Poole [at.el]," Plant disease severity estimate visually and by Hyper spectral imaging, "Plant Science, 2010 pp.59-107.
[8] De Cui, Qin Zhang [at.el],"Detection of soybean rust using a multispectral image sensor," Springer Science, 2009, pp.49-56.
[9] Apan, A.Weld [at.el],"Detecting sugarcane 'orange rust' disease using EO-1 Hyperion hyper spectral imagery, "International journal of remote sensing, 1998, pp.657-675.
[10] Kridsakron Auynirndronkool, Varinthon Jarnkoon,"Analysis of economic crop reflectance by field spectral signature, case study sugarcane", Journal of plant physiol, 2008, pp.1-9.
[11] Au Dimitrios Moshou, Cedeic Bravo," Automatic detection 'yellow rust' in wheat using reflectance measurements and neural networks , "Elsevier, 2004, pp.173-188.
[12] Dae Gwan Kim, Thomas F. Burks,"Classification of grape fruit peel diseases using color texture feature analysis", IJABE, 2009, pp.41-50.
[13] Rajesh Pydipali," Evolution of classifiers for automatic disease detection in citrus leaves using machine vision", PG Thesis, University of Florida, 2006.
[14] Rafael C, Gonzalez, Richard E. Woods, Steven L.Eddins, "Digital Image Processing Using MATLAB," Pearson Publication, 2008.
[15] Sanjay B. Patil, Dr S.K.Bodhe,"Image processing technique for betel leaf area measurement," IJMRAE, 2011, pp. 255 - 262.
[16] Y.Sun, D.L.Page [at.el]," Triangle mesh-based edge detection and its application to surface
[17] segmentation and adaptive surface smoothing ", IEEE, 2002, pp825-828.