Segmentation of Defected Regions in Leaves using K- Means and OTSU's Method

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***Abstract* — Image segmentation is the process of dividing a digital image into multiple fragments. The main theme of segmentation is to represent or convert the image to simplest form for further processing. Image segmentation is most widely used to locate objects and boundaries in images. More clearly, image segmentation is the process of assigning an address to every pixel in an image, so that the pixels having same property can share certain characteristics. In existing method, thresholding and histogram techniques are used for segment the defected regions in leaves. Thresholding is one of the segmentation method which is used for segmenting the image by fixing a threshold value and histogram is a method used for collecting the information about the image from its background. The drawback of this method is that it does not provide proper segmentation region. So in order to overcome these drawbacks in the proposed, K-means algorithm and Otsu's methods are used to segment the defected regions in leaves. In K-means segmentation algorithm, defected image is grouped into eight clusters which depends on its intensity and an iteration process. Each and every time the cluster center value is changed depends upon the minimum Centroid value. Finally the given image is segmented in order to identify its defected regions. The next is the Otsu's method is one which is used to segment the image by automatic thresholding process. Each and every time in the process, the threshold value is changed based on its mean and variance value, at last the maximum variance value is considered as the threshold value. Then the proposed method provides better segmentation result when compared with the existing methods in terms of defect identification with accuracy.**

Keywords — K-means algorithm, Otsu's method, image segmentation.

I. INTRODUCTION

Segmentation is the process of partitioning an image into multiple fragments. The main theme of segmentation is to represent or convert the image to simplest form for further processing [2]. Image segmentation is widely used to identify the objects and boundaries in the image. Most clearly, image segmentation is the process of giving an address to every pixel in an image such that pixels with the same address share certain characteristics. Each of the pixels in a region is similar with respect to some manner or computed property, such as color, intensity levels, or texture [3]. Adjacent regions are accordingly different with respect to the same characteristics.

In existing work, thresholding and histogram analysis are used to perform image segmentation. In thresholding method, the image is segmented based on the threshold value [5]. A common threshold is calculated that can be used to change the gray image to a binary image. Initially an image is divided into two regions using the initial threshold value; the image is separated from its background value. Then the new threshold value is calculated, this process is repeated again and again until the threshold value does not changes. The main disadvantage in thresholding method is that identification of peaks and valleys in the image is very tedious process, which means with thresholding only intensity value is considered, not any relationship between the pixels. There is no guarantee that the pixels identified by the thresholding process are continuous. In order to overcome these drawbacks a histogram based method is introduced. In histogram seeking method, given image is converted into gray level image and based on the threshold fixed the image is divided into two regions. Its value is computed and the histogram of the image is obtained. But, the quality of the output is not good.

The paper flow is as follow: part II describes the existing technique results and discussion. Part III describes the proposed work and discussion. Part IV provides the proposed system results and comparison. Part V conclusion of the work.

II. EXISTING WORK

The main theme of this paper is to identify the defected parts in an infected leaf image.

A. Thresholding

Thresholding is the easiest method in image segmentation process. It can be obtained by considering the predefined value called threshold. Using the threshold the gray level image is changed to binary format. Thresholding is used to extract a required content from the given image by fixing a T (threshold) value for each pixel such that each pixel is either classified as a required content and a region not in the area of interest. Pixel above the threshold is considered as one and below the threshold is considered as zero. This is given by

$$g(x,y) = \begin{cases} 1 \; if \; f(x,y) > T \\ 0 \; if \; f(x,y) \leq T \end{cases} \qquad (1)$$

Thresholding is one of the most commonly used method in segmentation technique. It works by converting the original image into gray scale image by partitions the image using the threshold condition. Based on the threshold value the defected image is segmented.

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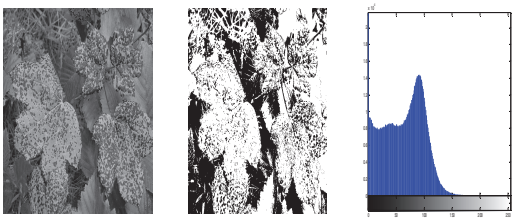


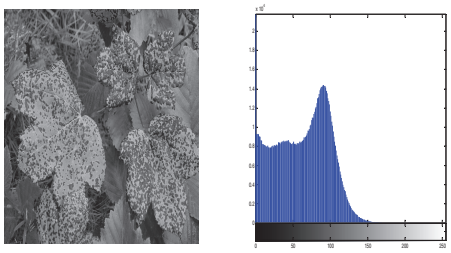
(a) (b) (c)

Figure 1: (a) Defected leaf 1 (b) Segmentation based on thresholding (c) Histogram

Figure 1 shows the original gray scale image and shows the result after segmentation and its corresponding histogram.

B. *Histogram based method*

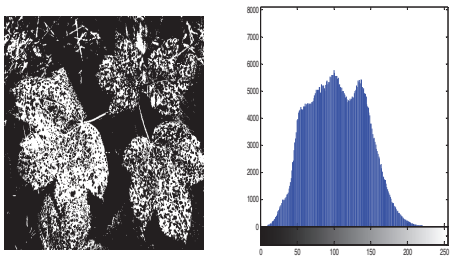
Histogram based method is most effective method compared with other segmentation techniques. Histogram is calculated from all of the pixels in the image, and the center of the cluster is located by using the peaks and valleys in the image. Repeatedly apply this method in order to segment the image into smaller units. This process is repeated in order to split them into smallest units until no more large units are found. Histogram gives the diagrammatic representation of the tonal distribution in the image by processing its peak and valley points [1], [8]. Histogram is calculated for all the pixels in the image. Histogram plots contain number of pixels in the x-axis and intensity value in the y-axis. In histogram seeking method, original image is converted into gray scale format and based on the threshold fixed the image is divided into two regions. Its value is computed and the histogram of the image is obtained.



(a) (b)

Figure 2: (a) Defected leaf Image 1 (b) Histogram

It is one of the most used method in image segmentation process. It is used to partition the given image based on the threshold condition and its output is displayed in the graphical form. It is very useful to identify the tonal distributions in the image.



(c) (d)

Figure 3: (a) Output Image (b) Histogram

Figure 2 shows defected leaf image and its histogram value and figure 3 shows the result after segmentation and its histogram value.

III. PROPOSED WORK

The proposed system consists of two methods which are used to partition the image. K-means [9] and Otsu's method are used to partition the image in order to identify its defected regions properly.

C. *K-means Clustering Algorithm*

The K-means algorithm is a repetitive process used to split a color image automatically into K clusters [2], [4], [6], [10].

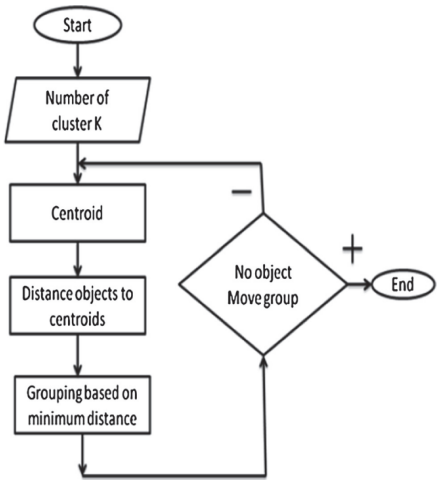


Figure 4: Flow Diagram for Proposed Algorithm

Algorithm steps are

a) Initially K cluster centers are fixed it can be in random manner or in some specific format.
b) Then each and every pixel is assigned to the cluster which minimize the distance between the pixel and center of the cluster.
c) Recalculate the center cluster value by using all the points in the cluster.
d) Update step b and c until no pixels changes its clusters.

In order to explain more clearly the flow diagram for proposed K-means algorithm is given in fig 4.

Wherein the given image is first split into number of clusters based on the requirement. Centroid for each cluster is calculated with minimum distance between the pixels, each and every time the Centroid is recomputed because it is an iterative process. Finally, it checks whether every points in the image is accommodated into the cluster, if the condition is true means the process is stopped and the segmented image is produced as output if not the operation repeated until we get the proper segmented result.

The aim of the proposed work is to identify the defected parts in the image. Clustering is one of the most widely used technique in image segmentation wherein k-means clustering algorithm is one famous automatic iterative technique used to separate the image into K-clusters. The number of cluster is desired by the user. More number of clusters provides the better result of understanding.

Initially an image is divided into K-clusters based on the cluster value defined and center of the cluster is calculated. Then iterative process is taking placed. For each and every iteration it recalculates the cluster center value till no more pixels changes its cluster value. It provides it provides better result when compared with the existing method.

D. Otsu's method

It automatically performs clustering based image thresholding. Algorithm works based on the clustering process [7]. It works with binary images. The simple algorithm steps are given below:

a) Compute histogram value and probabilities of each and every intensity level
b) Setup initial class variance and class mean values
c) Setup for all possible threshold values (t=1, .. ,maximum intensity value)
d) Replace variance and mean values for each iteration.
e) Compute total variance value (σ_b^2 (t))
f) The threshold value is desired corresponds to the maximum variance (σ_b^2 (t)).

IV. EXPERIMENTAL RESULT

E. K-means Clustering Algorithm

To explain the working of the proposed method, the leaf image is taken for the case study. The proposed method is processed on the infected leaf image. We have segmented the leaf image in order to identify its defected parts.

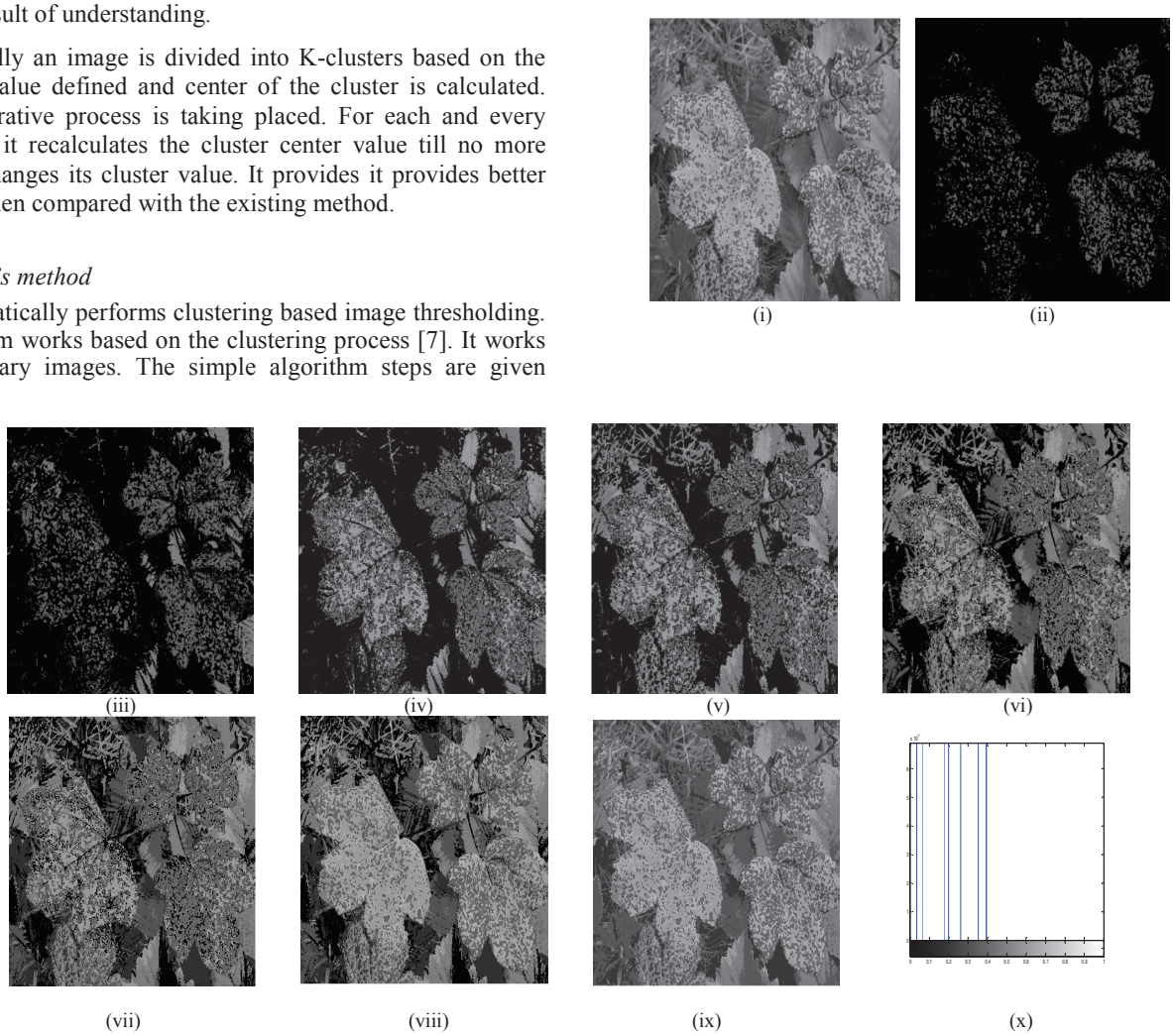
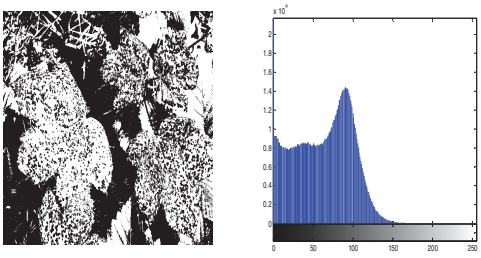


Figure 5: experimental results using k means clustering algorithm. (i) Original leaf image 1 (ii) segment one (iii) segment two (iv) segment three (v) segment four (vi) segment five (vii) segment six (viii) segment seven (ix) segment eight (x) Histogram of output image.

For each segmentation the defect is identified correctly. The output histogram shows the defected levels are indicated with high intensity.

B. Otsu's method



(a) (b)

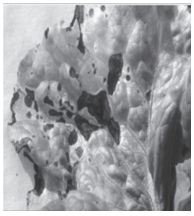
Figure 6: (a) Output of Otsu's method (b) histogram

Otsu's method is also used for identifying the defect present in the image. It is an iterative method performs segmentation based on the threshold values. Each time the new threshold is computed, and then the threshold is desired based on the maximum variance. It automatically fixes the threshold and performs segmentation and produces the result. The output produced by this method is very clear and accurate. It is more efficient than the previous method. The experimental results for Otsu's method are given in figure 6.

C. Comparisons of Methods

The techniques are analyzed with some more leaf images and their results are compared with its PSNR value. The below table indicates the parametric comparison of the existing with the proposed methods for three input images. From the table I, it is clear that the proposed method provides better results than the existing method.

TABLE I. COMPARISON OF METHODS

Name of The Input Image	**Input Images**	**EXISTING METHODS**		**PROPOSED METHODS**	
		Thresholding Method PSNR(dB)	***Histogram based Method PSNR(dB)***	***K-means Algorithm based Method PSNR(dB)***	***Otsu's Method PSNR(dB)***
Leaf Image 1		25.70	27.07	28.03	33.31
Leaf Image 2		26.29	26.45	26.81	26.24
Leaf Image 3		20.77	21.06	23.05	31.73

In table 1 the PSNR values are calculated for both the existing and the proposed methods. In existing method, the thresholding based method achieves a PSNR value in the range about 20 to 26 dB whereas the histogram based method contains 21 to 27 dB ranges. In K-means clustering algorithm, PSNR ranges from 23 to 28 dB and Otsu's method the PSNR value is in the range of 26 to 33 dB range. The quality of the output image produced by the proposed method is good qualitatively. K-means algorithm provides defected intensity value in the scattered manner and Otsu's method provides the density of the defected content in the image.

V. CONCLUSION

The framework for defect segmentation of image was proposed and evaluated in this work. The given image is

segmented using K-means and Otsu's methods. The proposed algorithm identifies the defect in the image very efficiently and accurately. It identifies the defected parts in the leaf images very precisely. In K-means clustering method, the defected regions are segmented by dividing them into number of clusters wherein each cluster contains group of pixel and in Otsu's method the defected image is segmented based on the automatic thresholding process each time the new threshold is calculated. Both the Proposed methods are iterative to produce the output. The corresponding results shows that the proposed method provides more details about the defected parts in the image and also it will provides better PSNR values than the existing methods. Hence it can be concluded that K-means and Otsu's methods can be used for segmentation of defected region in leaf images.

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