Image Enhancement Technique by Mean Partitioning of Multipeaks Histogram and Contrast Control Parameters

Pavithra P
REVA University,
Bangalore, India.

Sailaja
REVA University,
Bangalore, India.

Dr. Aishwarya P
Atria Institute of Technology,
Bangalore, India.

Kamalam Balasubramani
Atria Institute of Technology
Bangalore, India.

***Abstract*- In agriculture, research of automatic leaf disease detection is an essential research topic as it may prove benefits in monitoring large fields of crops, and thus automatically detects symptoms of disease as soon as they appear on leaves of the plant. As a first step in leaf disease detection, the image may have to undergo prepossessing. In the preprocessing step, the image is enhanced for the better machine vision or human vision and hence helps in accurate analysis. The most commonly used image enhancement techniques is the histogram based enhancement such as histogram equalization and histogram specification. In this paper, histogram based enhancement techniques proposed which is modification of the traditional histogram equalization. In this method, we consider the fact that it is not necessary to apply the same transformation function to all the pixels, unlike in the tradition histogram equalization. The pixels with lower intensity need a different transformation and the brighter pixels need a different transformation. The output images are subjected to subjective and objective quality analysis. It is observed that the proposed method results are better than the Global Histogram Equalization (GHE) and Contrast Limited Adaptive Histogram Equalization (CLAHE).**

Keywords*- *Image Enhancement, Histogram Equalization, Diseased Leaf, Entropy

I. INTRODUCTION

In India, most of the agriculture is done in small piece of land and the property ownersare completely responsibility for the crop. For such farmers the identification of plant disease is only through experience. If the farmer is unaware of some of the symptoms of a disease, the crops are under risk and to reach an expert to seek help is far more expensive for a remote farmer [2]. Technological assistance to such independent farmers would be of great help to identify and seek remedial measures to prevent disease spreading, hence yield lose.

Image Processing helps to extract useful information from the botanical images captured in the visible spectrum[15]. Hence, there is immense need in using advanced image processing techniques for technology-assisted agriculture [4][6][1].

In agriculture, research of automatic leaf disease detection is essential topic as it may prove benefits in monitoring large or small fields of crops, and thus automatically detect symptoms of disease as soon as they appear on plant leaves. Fungi, bacteria and viruses cause most leaf diseases, which has visible symptoms shown on the surface of the leaf. Many a times the symptoms on leaves maynot be identifiable due to lack of clarity in the input image. This could be due to noise in the image, improper or no illumination [10][11]. Noise may be induced in the image during acquisition, transmission or storage in the database.Thus the most important and foremost step in analysis of the leaf texture is the enhancement of the image such that it is more suitable for analysis by the user[5]. In this paper, a solution to the problem due to illumination is proposed.Histogram processing is one commonly used spatial domain image preprocessing technique [18].

II. GLOBAL HISTOGRAM EQUALIZATION (GHE)

GHE is one of the very well known techniques to enhance contrast of the image. This enhancement technique works towards distribution of equal number of pixels to all the grey levels[14]. The global histogram equalization on this process enhances the pixel values to a level that reaches saturation[17]. This leads to over enhancement of some part of the image as a result the next level processing of the image, by human or computer vision is adversely affected.

The description of the general procedure of GHE is below:

Considering the input image as two dimensional matrix and (i,j) denotes the position i^{th} row and j^{th} column in the image of size MxN and X(i, j) denotes the gray-level of a pixel at (i, j). The total number of pixels in the image is N*M and the image intensity is digitized into Lgray levels that are [X_0, X_1, . . . ,$_{-1}$], generally L=256. Let n_k represent the number of times the intensity X_k appears in the input image X, then the Probability Density Function (PDF),(X_k) for the level $X_k$is defined as

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

$P(X_k) = n_k/N*M,\ k = 0, 1, \ldots, -1.$ - - - - - - (1)

The computational function of Cumulative Density Function (CDF) for the histogram is

$C(X) = \sum_{j=0}^{k} P(Xj)$. - - - - - - (2)

GHE maps the input image into the entire dynamic range,(X_0, X_{L-1}), by using the CDF as a transform function. The transform function (X) based on the CDF is defined as

$f(X_i) = X_0 + (X_{L-1} - X_0)\ C(X_i)$ - - - - - - (3)

Most of the histogram based enhancement techniques apply the same principle with changes in the transformation function.

Histogram equalization method aims at flattening the histogram by which it achieves image enhancement.But, these methods change the mean brightness of the image and also introduces artifacts by over enhancement of image most of times this would result in the change in the amount of information content in the image.

Hence,the proposed algorithm treats the brighter pixels and darker pixels in a
different way during the transformation unlike the GHE where every pixel undergoes the same transformation. The enhanced images are subjected to quality metrics, which could be objective or subjective evaluation, based on whether the enhanced image is used by computer vision or by human respectively. Most of the automatic image enhancement techniques do not score the same in subjective analyses since the definition of "good" image of each individual is different. Hence, we introduce an algorithm, which allows the human to control the amount of enhancement required on the input images.

III. LITERATURE REVIEW

The authors of [12] paper has proposed the muiltipeak based histogram equalization where the each detected peak is processed separately to preserve the brightness but still enhance the image. This method helped prevent the brightness saturation due to global equalization.

The authors in [9] paper have worked on the generalization of multi-peak GHE approach where new pixel value depends not only on intensities u(x, y), but also on the local information v(x, y) of each pixel where (x,y) is the pixel coordinates in the image.

The paper[21], presents a review of various commonly used histogram based enhancement techniques proposed for gray scale static images. These enhancement techniques majorly differ in the way the histogram is divided for processing.

The basic idea of the authors of paper [19] is, computing mean value of multiple peaks in the input image's histogram and the input image histogram is segmented into two sub histograms based on this multipeak mean. Then, the two sub histograms were modified separately by computing the optimal contrast enhancement using swarm intelligence. This method enhanced the input image in a better way than the existing contemporary histogram enhancement methods. In paper [22], a variation of AHE has been proposed by the author *Sanparith Marukatat*. His method uses the local parametric values for enhancement which reduces computation intensity. The proposed technique called Local Intensity Distribution Equalization (LIDE) takes parametric cumulative distribution function into account, which is computed, in a window around each pixel to enhance local detail in the window. A data structure called integral image was used for faster calculation.

IV. PROPOSED METHOD

In this paper, we describe the enhancement method that enhances higher valued pixels and lower valued pixels in different scales. The main aim of the experiment is to enhance the image such that enhancement of the darker and the lighter pixels are controlled separately in a way that the over enhancement of the brighter pixels and suppression of the darker pixels are as per the requirements of user. This is done by dividing the histogram of the original image into two based on the mean of the multipeaks in the original histogram. All the
pixels histogram less than the mean of the peaks will fall into the lower sub histogram and the other pixels fall into the higher sub histogram.Two contrast control parameters, $\boldsymbol{\alpha}$and $\boldsymbol{\beta}$ helps to control the amount of enhancement required.$\boldsymbol{\alpha}$controls the modification of the lower sub histogram and $\boldsymbol{\beta}$ controls the upper sub histogram. Then,these two modified sub histograms are combined to get the final enhanced image.A similar work, proposed by Babu et al[19], uses the swarm intelligence technique to give values to the contrast control parameters automatically. Since the definition of "good" enhancement is subjective to the user of the image, the proposed method does not implement automation of the control parameters. For the convenience of the user, we provide the contrast control parameters to be manually selected.

A. Formula

Our proposed method generates the modified histogram *HmU*, for upper sub-histogramsuch that it is inclined towards the global histogram of upper sub-histogram uiU for enhancement, but still maintaining the input image brightness HiU. The parameters $\boldsymbol{\alpha}$and $\boldsymbol{\beta}$controls the inclination of modified histogram towards the original upper sub-histogram and the inclination towards the equalized histogram.

$$HmU = \frac{HiU+\beta u}{1} + \beta \qquad ----(4)$$

$$HmU = \frac{1}{(1+\beta)U} + \frac{\beta}{(1+\beta)uiU} \qquad ----(5)$$

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

B. Contrast Control Parameter

The value of the contrast control parameters, $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$, is in the range from 0.0 to 1.0. For low value of these parameters, the transformation function is saturated which would result in over enhancement of the image. Large values of the parameter, towards 1.0, generate transformation, which preserves the naturalness of the image with increased image quality. The various changes in the levels of contrast enhancement can be achieved by changing the values of these parameters.

The algorithm of the proposed work is described below:
Input: An image of size MxN in the gray-level range X[0−1], contrast control parameters $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$.
Output: The contrast enhanced image

BEGIN

Step 1. Divide the input image histogram into two sub histogram (lower and upper sub-histogram of the object) based on multi-peak mean value.
Step 2. Generate the input histograms $HiL$and $HiU$for lower and upper sub-histogram separately.
Step 3. Generate an equalized histogram $uiL$for lower sub-histogram and uiUforupper sub- histogram image
Step 4. Select values of the contrast enhancement parameters $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ for lower and upper sub- histogram
Step 5. Compute the modified histogram $HmL$for lower sub histogram and for upper sub-histogram image
Step 6. Combine the two modified sub-histograms into a single histogram and display the final contrast enhanced image

END

The above described algorithm has been implemented in MATLAB. MATLAB provides special tools for performing experiments on image processing algorithms [15].

C. Results

Jowar plant leaf images were capture from the field and modified for the experiment. The image obtained is show in figure 1. These images were given as input for the implement algorithm with varying $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ values. The output images obtained are show in *figure 1*. The main purpose of the experiment was to generate output images that would be rich in information content and still be pleasing for the user. Hence, the output images were subjected to quality analysis where in the entropy of the images were calculated for comparison of our output images with the global Histogram Equalization (GHE) and Contrast Limited Adaptive Histogram Equalization(CLAHE) methods. Because of its simplicity in computation and effective contrast enhancement, GHE is one of the common methods for image enhancement [13]. And Contrast Limited Adaptive Histogram Equalization (CLAHE) is one of the most successful adaptive histogram equalization specially effective in biomedical image analysis and underwater image procssing[18]. Hence we choose GHE and CLAHE for comparing the result of our method[16].

Entropy is the measure of average information contents of the image[8][20]. The higher value of Entropy, towards 8, shows the richness of theinformation in the output image[20]. Theentropy, *E*, is defined as

$$E = P(k)*\log P(k) \text{- - - - (6)}$$

Where, *P(k)* is the Probability Density Function of the k^{th} gray level.

V. CONCLUSION

The results show that the proposed work enhances the images better than the global histogram equalization in increasing the information content and the output image looks better to the user as the enhancement level is controlled, by the contrast parameters. The image selected is dark, more transformation is required for the lower sub histogram than upper sub histogram, from equation (4) and (5), low values of control parameters will give over enhancement or saturation and high values will yield in preserving naturalness.

Hence the optimal value of the parameters $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ for the selected image were observed to be 0 and 1 respectively. The work can be enhanced by applying a new transformation function for the mean of multi peaks histogram partitioned image enhancement technique.

$\boldsymbol{\alpha}$	$\boldsymbol{\beta}$	Proposed method
0	1	7.7949
0	0.75	7.7947
0	0.5	7.7931
0	0.25	7.7886
0	0	7.7713
1	0	6.8616
0.75	0	7.2530
0.5	0	7.2530
0.25	0	7.4975
0.25	0.75	7.5019
0.5	0.5	7.2564
0.75	0.25	7.0454

Table 1. Result of Entropy measure for proposed methods for different values of $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$

Input Image	GHE	CLAHE
4.5706	4.4829	5.6535

Table 2. Result of Entropy measure for Input image, GHE and CLAHE

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

REFERENCES

[1] Abhishek Banerjee, “Impact of Principal Component Analysis in the Application of Image Processing”, International Journal of Advanced Research in Computer Science and Software Engineering, ISSN: 2277 128X,Volume 2, Issue 1, January 2012
[2] Anne KatrinMahlein, “Plant Disease Detection by Image Sensor- Parallels and Specific Demand for Precision Agriculture and Plant Phenotyping”, The American Phytopathological Society Journals, February 2016, Volume 100, Number 2, Pages 241-251.
[3] Ayodeji S. Makinde, Yaw Nkansah- Gyekye, 3 Loserian S. Laizer, "Enhancing the Accuracy of Biometric Feature Extraction Fusion Using Gabor Filter and Mahalanobis Distance Algorithm", (IJCSIS) International Journal of Computer Science and Information Security, Vol. , No. 7, July 2014.
[4] A Fakhri A Nasir, M Nordi A Rahman and A RasidMamat, " A Study of Image Processing in Agriculture Application under High Performance Computing Environment", International Journal of Computer Science and Telecommunications Vol 3, Issue 8, August 2012
[5] A. Kumar and F. Shaik, “Image Processing in Diabetic Related Causes”, Forensic and Medical Bioinformatics, ISBN:978-981-287-623-2, Volume 1, pp 56, 2016
[6] BinnyThakral, MD. Tausif Ahmad, Mandeep Kaur, Ishteaque Ahmad, Sonia, “A Review of Various Image Enhancement and Noise Removal Methods”, International Journal of Advanced Research in Computer Science and Software Engineering,ISSN: 2277 128X Volume 6, Issue 3, March 2016
[7] David Sunding and David Zilberman, “The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural Sector”, Handbook of Agricultural Economics, Department of Agricultural and Resource Economics, University of California at Berkeley, 2010
[8] Gwanggil Jeon, "Image Enhancement Techniques using Information Entropy", Advanced Science and Technology Letters Vol 31 (MulGraB 2013), pp. 172-175
[9] H.D. Chengand X.J. Shi, “A simple and effective histogram equalization approach to image enhancement”, Elsevier, Digital Signal Processing 14 (2004) pg.158–170
[10] H. K. Sawant, Mahentra Deore, “A Comprehensive Review of Image Enhancement Techniques”, International Journal of Computer Technology and Electronics Engineering (IJCTEE) Volume 1, Issue 2, ISSN 2249-6343**,** 2015**,** pp. 39
[11] Jenish Sherin.B.T1, Jemimah Simon, “Image Enhancement for Non-uniform llumination Images using PDE”, International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 International Conference on Humming Bird, March 2014,pp 30
[12] K. Wongsritong , K. Kittayaruasiriwat, F. Cheevasuvit, K. Dejhan, and A. Somboonkaew, “Contrast Enhancement Using Multipeak Histogram Equalization With Brightness Preserving”, EEE Asia Pacific Conference on Circuits and Systems Proceedings, November 1998, pp. 455–458.
[13] Manpreet Kaur, Jasdeep Kaur, Jappreet Kaur, “Survey of Contrast Enhancement Techniques based on Histogram Equalization”, (IJACSA) International Journal of Advanced Computer Science and Applications, 2011, Vol. 2, No. 7.
[14] MireiaFarrus, PascualEjarque, Andrey Temko, Javier Hernando, "Histogram Equalization in SVM Multimodal Person Verification" Springer Berlin Heidelberg, Advances in Biometrics, International Conference, ICB 2007, Seoul, Korea, August 27-29, 2007. Volume 4642, pp 819-827
[15] M.A. Shaikha, S.B. Sayyad, "Color Image Enhancement Filtering Techniques for Agricultural Domain Using MATLAB", ISRS Proceeding Papers of Sort Interactive Session ISPRS TC VIII International Symposium on "Operational Remote Sensing Applications: Opportunities, Progress and Challenges", Hyderabad, India, December 9-12, 2014
[16] Neethu M. Sasi, V. K. Jayasree, “Contrast Limited Adaptive Histogram Equalization for Qualitative Enhancement of Myocardial Perfusion Images”, Scientific Research, Engineering, 2013, vol. 5, Pg. 326-331
[17] Omprakash Patel, Yogendra P. S. Maravi and Sanjeev Sharma, “A Comparative Study Of Histogram Equalization Based Image Enhancement Techniques For Brightness Preservation And Contrast Enhancement”, Signal & Image Processing: An International Journal (SIPIJ) Vol.4, No.5, October 2013, pp 11
[18] Pooja Rana, Vinay Chopra, "A Study on Image Enhancement Techniques", International Journal of Advanced Research in Computer and Communication Engineering Vol. 1, Issue 5, May 2015
[19] P. Babu, V. Rajamani, and K. Optimized Histogram Modification Framework Using Swarm Intelligence for Image Contrast Enhancement”, Mathematical Problems in Engineering; 7/6/2015, Vol. 2015, p1
[20] Ramyashree N, Pavithra P, Shruthi T V, Dr. JharnaMajumdar, “Enhancement of Aerial and Medical Image using Multi resolution pyramid”, International Journal of Computer & Communication Technology (IJCCT) for International Conference on Advances in Computer, Communication Technology and Applications, 2010, Vol. 1 No. 2,3,4. Page no. 202- 209
[21] Sanparith Marukatat, “Image enhancement using local intensity distribution equalization”, EURASIP Journal on Image & Video Processing; 9/5/2015, Vol. 2015 Issue 1, p1
[22] Saravanan S, P. Siva Kumar, “Image Contrast Enhancement Using Histogram Equalization Techniques: Review”, International Journal of Advances in Computer Science and Technology, March 2014, ISSN 2320 – 2602, Volume 3, No.3

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

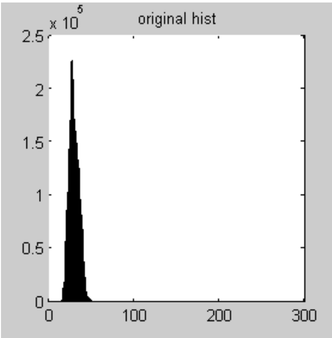
International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 11, November-2016

RESULTS

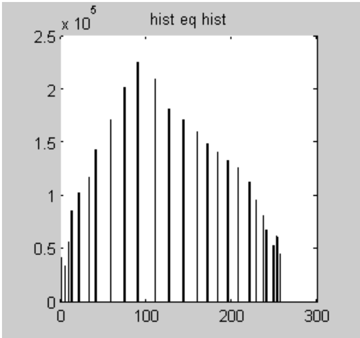
Original leaf image

Enhanced by global histogram equalization

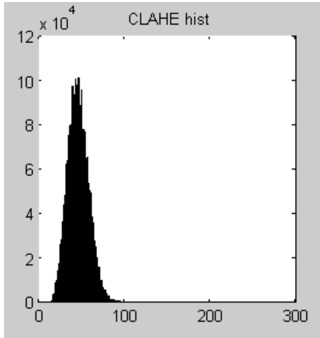
Enhanced by CLAHE



Histogram of Original leaf image



Histogram of the leaf enhanced by global histogram equalization



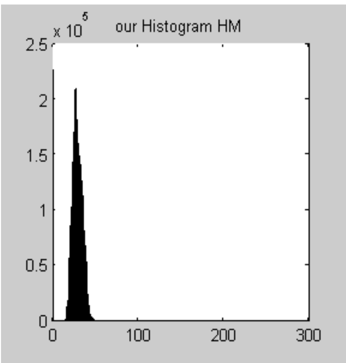
Histogram of the leaf enhanced by CLAHE

α=0 β =0

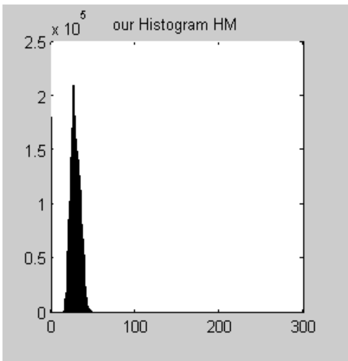
α=0 β =0.25

α=0.5 β =0

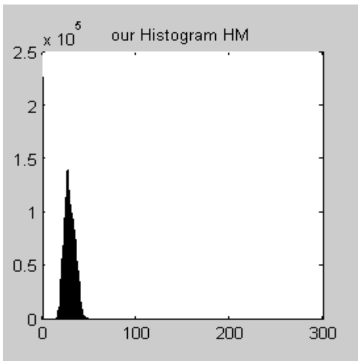
Output of the proposed method for varying values of α and β



α=0 β =0



α=0 β =0.25



α=0.5 β =0

Output histogram of the proposed method for varying values of $\varphi 1$ and $\varphi 2$

Figure 1. Input and out images of Jowar leaf

(This work is licensed under a Creative Commons Attribution 4.0 International License.)