ISSN: 2455-1848
International Journal of Innovative Research & Growth
A Peer Reviewed & Referred International Journal
Volume-8 Issue-6 April-2019
Impact Factor-3.0
www.ijirg.com, editor@ijirg.com

Two Stage Histogram Enhancement Schemes To Improve Visual Quality Of Funds Images

[1]Ankit Chourasiya, [2]Neha Khare
[1,2]Takshshila Institute of Technology Jabalpur, Madhya Pradesh, India
Email: - chourasiyaji11@gmail.com, nehakhare@takshshila.org

Abstract
Main objective of image enhancement is to process an image in order that result is more appropriate than original image for specific domain. To increasing the visual quality of image, image enhancement technique provides the large number of choices or methods. Application selection of such techniques is greatly influenced by the imaging modality, task at hand and viewing condition. This paper can give the detail of my proposed method that use to enhance the quality of funds images and the methods that use here is contrast limited histogram equalization for local enhancement and recursive separated and weighted histogram equalization for global enhancement.
Keywords: *- image enhancement, histogram equalization, RSWHE, CLHE.*

1- INTRODUCTION

Image enhancement is one amongst the outstanding pre-processing steps in image processing application. In image enhancement subjective quality of image has given a lot of importance instead of objective quality of a image. Mainly used image enhancement techniques are edge enhancement and contrast enhancement. To enhance the sharpness of edges and to improve the visual quality of an image, edge enhancement and contrast enhancement is used respectively **[1].** One of the well-known method to improve the contrast of an image is histogram equalization (HE) because it is easy to implement and fast as compared to other methods. Enhancement of an image can be performed in a grey image as well as color image. Enhancement of the color image is more complex than the grey image because the different color image may have a different color model and different color model has different component structure. To improve the quality of image first we need to fixed color model of an image and then component which need to be improving **[2].** One of the efficient method to improve the visual quality of color image and it also overcome the disadvantage of conventional HE is Recursive Separated and weighted Histogram Equalization (RSWHE).

Image enhancement has major role in medical domain to analysis the medical digital images. Various enhancement methods are used for medical image enhancement as pre-processing step. Some of the medical imaging techniques are computed tomography, x-ray, magnetic resonance imaging, etc. are mainly used for capture human body parts for diagnostics purpose. Many algorithms are created to improve the visual quality of these images. One of the algorithm that is mostly used in medical domain to enhance these images are Contras Limited Adaptive Histogram Equalization (CLAHE) **[3].** One of the major areas of research in medical domain is fundus image. Many of the researchers are working to improve the visual quality or contrast of fundus image. Funds camera is used to capturing of fundus image.

Camera captures the inner side of the eye and capture image is colored image. So contrast enhancements are performing in the color image.

In the work **[4]** the authors have suggested a method that uses the Fuzzy logic and Histogram Based Enhancement (FHBE) method and Contrast Limited Adaptive Histogram Equalization (CLAHE) in its processing. Through our study we have observe two major problems in the work of **[4]** which is going to discuss in section 2.

In this paper we are going to replace one of the method for further improvement of fundus image. In place of FHBE we are going to use RSWHE which overcome the problem of FHBE.

This paper is organized as follow section 2 give the overview of the base method [base paper reference] and problem on the work, description of few basic concepts like RSWHE method, CLAHE method, HSV color model in section 3 and section 4 give the description of proposed method. Experimental result is given in the section 5.

2- THE BASE METHOD

In base method [base paper reference] original author has suggested FHBE method to improve low contrast and low brightness of color image. In FHBE method poor contrast image which has RGB color model converted from HSV color model and then computation is perform only in v component. After all the computation is done on input color image than HSV color space is again converted to RGB color space to obtain the final improved image. Through our study we have observed two major problems in the work of [base paper reference]. Now we are going to discuss these problems.

- The first problem is the use of FHBE method. As it is well known that the FHBE method suffers from two major problems of the conventional histogram equalization method. The first problem is that the FHBE method is not able to preserve mean brightness in the processed image. The second problem is that in theory it is found that the FHBE method is not applicable for images having bright and dark regions. Because these regions cannot be well enhanced by the FHBE method.
- The second problem in the method of **[4]** is that the method is not able to preserve color information in the image.

To solve the above mentioned problems of the method suggested in [base paper reference]. We are improving it in a way such that the improved method does not suffer from the above mentioned problems. So in the improved version of the method suggested in [base paper reference], we are now replacing the FHBE method with the recursively separated and weighted histogram equalization (RSWHE) method [RSWHE PAPER REFERENCE]. Also for color preservation we are using the hue saturation value (HSV) color space [HSV TO RGB REFFERNCE]. The RSWHE method does not have any such drawbacks as that of the conventional histogram equalization method. Also the HSV color space does not distort the color information of the input image into the processed image.

3- BASIC CONCEPT

3.1 The Recursive Separated and Weighted Histogram Equalization (RSWHE)

In RSWHE the input histogram of an image is going to change before performing the equalization procedure that make RSWHE method different from all other image enhancement method **[5]**. RSWHE has three modules namely they are histogram segmentation, histogram weighting and histogram equalization.

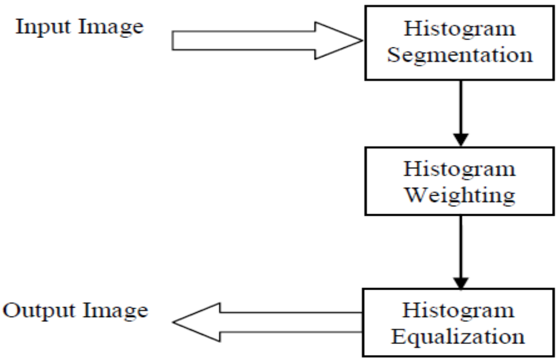

Fig 1. Block diagram of RSWHE

Fig. shows that the input to the histogram segmentation is image x. after taking input image x it perform computation and produce histogram H(x) and it recursively form a segments of the input histogram i.e. it create a sub histogram of input histogram. Segmentation is a procedure of dividing something into sub group. After completing the histogram segmentation the next histogram weighting is going to perform on sub histograms using the normalize power law function to modify them. The last module histogram equalization are going equalize the the modified sub histogram **[5]**.

Now we discuss all mathematic procedure which going out behind the all these three module in detail.

3.1.1 Histogram Segmentation Module

Computation of segmentation of H(X) is carried out recursively; the recursion is performing up to certain recursion level r. So that 2r sub-histogram originated. Actually the outcome two type of segmented result. We discuss them one by one.

a. Segmentation by Mean

Now the histogram H(X) which is segmented is represented by Ht(X) in the range of [Xl,Xu] and the recursion level is t(0≤t≤r). The mean is calculated as

$$X_M^t = \frac{(\sum_{k=l}^{u} k.p(k))}{\sum_{k=l}^{u} p(k))} \quad \textbf{(1)}$$

After computation of mean, the histogram Ht(X) is divided into two histogram Ht+1L(X) and Ht+lu(X) where they define over the [Xl, XMt] and [XMt + 1, Xu] respectively up to next recursion level t+1.

b. Segmentation by Median

In this case we are going to consider the again same situation as above. Here assume the CDF of grey level Xl and Xu is c(l) = m1, and c(u) = mu respectively. The median XDt calculated as

$$X_D^t = \textbf{argemin}_{l \le k \le u} \left| c(k) - \frac{m_1 + m_2}{2} \right| \quad \textbf{(2)}$$

Here again histogram Ht(X) is going to divided into two sub-histogram as same as in the case of segmentation by mean and define over the same range till next recursion level t+1.

3.1.2 Histogram weighting Module

After generating the 2r sub-histogram Hri(X) I is varied from (0≤i≤2r-1), based on the recursion level r.

This module performs the modification on the PDF of sub-histogram Hri(X) as follows:

a. it compute maximum probability and minimum probability by using (3) and (4).

$$P_{max} = \max_{0 \le k \le L-1} p(k) \quad \textbf{(3)}$$

$P_{max} = max_{0\le k\le L-1}\ p(k)$ **(4)**

b. Accumulative probability value α_i computed using the (6) and sum of them is equal to 1

$$\alpha_i = \sum_{k=l}^{u_i} p(k) \quad (5)$$

$$\sum_{i=0}^{2^r-1} = \alpha_0 + \alpha_1 + \alpha_2 .... + \alpha_{2^r-1} \quad (6)$$

After computing the probability the original PDF p(k) going to change into the weighted PDF using the (6)

$$p_w(k) = p_{max}\left[\frac{p(k)-p_{min}}{p_{max}-p_{min}}\right]^{\alpha_i} + \beta, (l_i \le k \le u_i) \quad (7)$$

Here the value of $\beta\geq 0$; by adjusting the β value the mean brightness is control and also contrast improvement is controlled. If the β value around $p_{max}|\ X_M - X_G|/(X_{max}-X_{min})$, whre X_{min} and X_{max} represent the minimum and maximum grey level of input image X.

c. Equation (7) is used to use to normalize modified PDF.

$$p_{wn}(k) = \frac{p_w(k)}{\left(\sum_{j=0}^{L-1} p_w(j)\right)} \quad (8)$$

3.1.3 Histogram Equalization Module

By using (6), (7), (8) this module equalize each of all 2^r sub-histogram. Give the final out by combining all resultant images.

$$p(k) = \frac{n_k}{N} = \frac{n_k}{n_0 + n_1 + ... + n_{L-1}}; fork = 0, 1, ..., L-1 \quad (9)$$

$$c(k) = \sum_{j=0}^{k} p(j) wherek = 0, 1, 2, ...L-1. \quad (10)$$

$$f(k) = X_0 + (X_{L-1} - X_0).c(k) \quad (11)$$

Here (9) is PDF which use in conventional histogram equalization method, (10) is cumulative distribution function and (11) level transformation function use in conventional approach.

3.2 Contrast Limited Adaptive Histogram Equalization (CLAHE)

Here contrast enhancement is done indirectly, so we can say that it is indirect contrast enhancement procedure and it is also elevated version of Adaptive Histogram Equalization (AHE) [link]. The major drawback of AHE is output enhance image has noise. This drawback is over come by CLAHE. Here the all procedure is same as AHE but one more step is going to follow here that step is before performing the computation of its CDF it clips the histogram. In CLAHE, image is divided into contextual region then local histogram is computed separately. Local contrast enchantment is more important in medical images. Calculating the clip limit based on the avg height and contrast factor ϒ which is define by the user is shown below

$$cliplimit = \gamma * avg_{height} \quad (12)$$

$$avg_{height} = (R \times c)/L \quad (13)$$

Size of the contextual region is represented by R×C and maximum possible grey level of an image is represented by L. degree of clip limit is manage by the contrast factor ϒ in range of 0<ϒ<1 [**4**]. Histogram specification is done just after the clipping of each non overlapping region (contextual region). After all these procedure is done then the contextual region is going to combine and then output is which we going to get is enhanced image.

3.3 The HSV Color Model

In HSV, H stands for hue; S stands for saturation and V stand for value. By selecting the range of from 0-360 which is hue range we are able to select any color. So we can say that it correspond to color component. Saturation is corresponding to depth of pigment and value is corresponding to the brightness of the color. The main motive behind the working with HSV version of any image is using hue component makes the algorithm less sensitive to lighting variation [7].

4- PROPOSED METHOD

Working of the proposed methods is shown in Fig. 1, the input low contrast fundus image is converted to HSV color space. Then the V channel of the image is used for overall processing of the method. As the idea of applying global contrast enhancement followed by local contrast enhancement and vice versa is discussed in **[4]**. Similarly we are applying this idea by replacing the FHBE method by RSWHE method. The proposed method is nothing but an improved version of the method suggested in **[4]**.

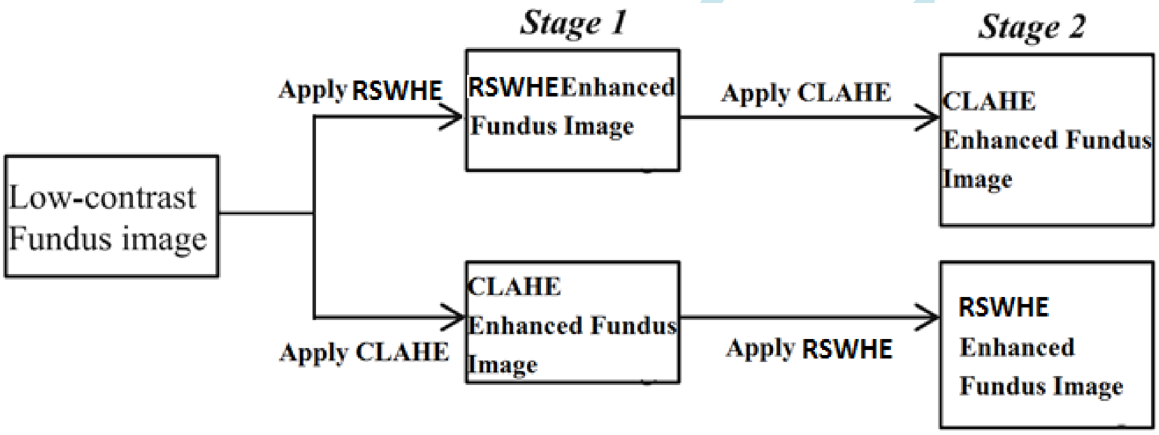

Fig. 2: flowchart of the proposed method**.**

5- EXPERIMENTAL RESULTS

For performance evaluation of the proposed method we have used the publicly available Messidor database **[8]**. We have used few images of the database in this work. As test methods we have used HE, CLAHE and RSWHE methods. A careful examination of Fig. 3: shows that the proposed methods are able to enhance local as well as global contrast of the image. As this enhancement operation is performed in the HSV color domain, hence no color information is distorted in the processed images. Also as the proposed methods use two widely accepted methods RSWHE and CLAHE in its processing, hence results produced by the proposed methods contain advantages of both methods. The RSWHE method is a good global contrast enhancement method which does not distort meaningful information of the image. This method provides maximum brightness preservation too. On the other hand the CLAHE method is the best method of local contrast enhancement.

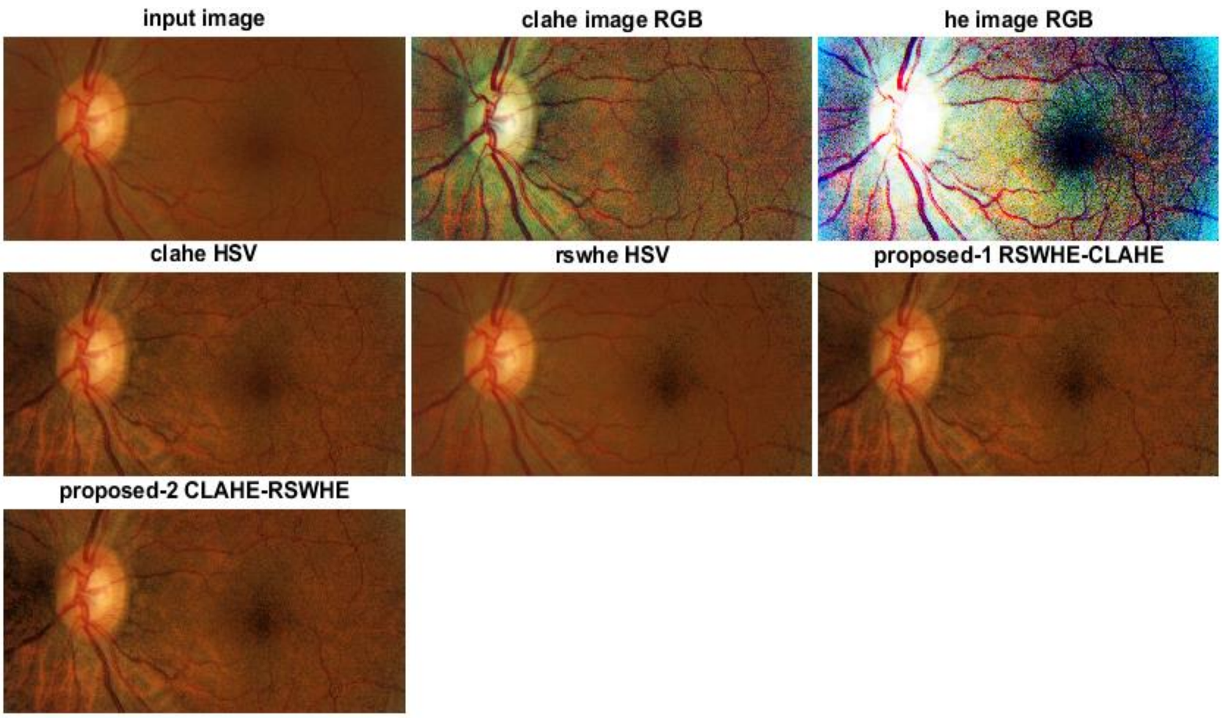

Fig. 3: shows results of various methods on the '**20051020_43832_0100_PP**' image.

Table 1: standard deviation results for all images

Input	HE-RGB	CLAHE-RGB	CLAHE-HSV	RSWHE-HSV	PROP-1	PROP-2
17.87	68.42	27.15	19.77	18.62	19.84	20.59

Table 1 shows standard deviation results of all the methods on given set of images. It is well known that mathematically root-mean-square contrast is nothing but standard deviation of the image. A deep observation of Table-1 shows that the proposed methods are able to enhance sufficient contrast in the images. As unlike HE-RGB the proposed methods do not over enhances the image. It is clear from Table-1 that the proposed methods are a good choice for optimal local and global contrast enhancement of all type of medical images.

6- CONCLUSION

In this work we have developed a method for local and global contrast enhancement of color retinal images. The proposed methods use two widely accepted methods RSWHE and CLAHE in its processing, hence results produced by the proposed methods contain advantages of both methods. The RSWHE method is a good global contrast enhancement method which does not distort meaningful information of the image. This method provides maximum brightness preservation too. On the other hand the CLAHE method is the best method of local contrast enhancement. In future the two methods namely RSWHE (for global contrast enhancement) and CLAHE (for local contrast enhancement) can be replaced with other methods.

7- REFERENCES

i. Shanmugavadivu, P., Balasubramanian, K.: Image edge and contrast enhancement using unsharp masking and constrained histogram equalization. In: Balasubramaniam, P. (ed.) ICLICC 2011. CCIS, vol. 140, pp. 129-136. Springer, Heidelberg (2011). https://doi.org/ 10.1007/978-3-642-19263-0_16.

ii. A.C. Bovik, Digital Image Processing Course Notes, Dept. of Electrical Engineering, U. of Texas at Austin, 1995.
iii. Etta D. Pisano; Shuquan Zong; Bradley M. Hemminger. "Contrast Limited Adaptive Histogram Equalization image processing to improve the detection of simulated spiculations in dense mammograms"
iv. Wahid, Farha, K, Sugandhi & Raju, G. "Two Stage Histogram Enhancement Schemes to Improve Visual Quality of Fundus Images" Second International Conference, ICACDS 2018, Dehradun, India, April 20-21, 2018, Revised Selected Papers, Part I. 10.1007/978-981-13-1810-8_1, (2018).
v. M. Kim and M. G. Chung, "Recursively separated and weighted histogram equalization for brightness preservation and contrast enhancement," in IEEE Transactions on Consumer Electronics, vol. 54, no. 3, pp. 1389-1397, August 2008.
vi. K. Zuiderveld, "Contrast limited adaptive histogram equalization", In: P. Heckbert: Graphics Gems IV, Academic Press 1994, ISBN 0-12-336155-9.
vii. Convert from HSV to RGB Color Space, "https://in.mathworks.com/help/images/convert-from-hsv-to-rgb-color-space.html ", Accessed on March 30, 2019.
viii. E. Decenciere et al., Feedback on a publicly distributed image database: the Messidor database, Image Anal. Stereol., vol. 33, no. 3, pp. 231-234, Aug. 2014.