A Method of Medical Image Contrast Enhancement Using Two Steps of Contrast Limited Adaptive Histogram Equalization

Rajshree Singh, Brajesh Patel
Shri Ram Institute of Technology, Jabalpur, Madhya Pradesh, India

Abstract*— This paper introduced two level contrast limited adaptive histogram equalization for enhancement of mammogram images. Instead of using a single desired histogram, this approach employed two different histograms for contrast limited adaptive histogram equalization (CLAHE) in which one CLAHE follows another CLAHE. Compared to CLAHE, transformation function of the proposed technique is monotonic, which is essential for gray level transformation. This new approach is tested on few images of MIAS database and the improved enhancement performance is compared with adaptive histogram equalization (AHE) and histogram equalization (HE).

Keywords*— histogram equalization, contrast enhancement, brightness preservation.

I. Introduction

The improvement of mammogram is particularly vital in medical imaging since it yields steady hand for analysis reason. In this paper, we build up another technique for upgrading the mammograms by applying Two-Stage contrast limited adaptive histogram equalization (TSCLAHE). There are numerous methods to improve the contrast, which amplifies the power contrast of the mammogram and bringing out more points of interest [1]. Image power dissemination is one of the imperative parameter conversely contrast limited adaptive histogram equalization (CLAHE) since it assumes a noteworthy part in the histogram shape and indicates the desirable histogram [2]. Likewise, CLAHE applies the method on little locales in the image called tiles as opposed to the whole image. Contrast in the tile is upgraded, with the goal that the histogram of the yield area roughly coordinates the uniform distribution. Notwithstanding valuable image insights, the data characteristic in histograms is likewise helpful in image contrast upgrade [3]–[5]. As of late another unsharp masking (UM) plot, called nonlinear UM (NLUM), for mammogram improvement is proposed in [6]. In this new approach, before the uniform appropriation coordinate as in ordinary CLAHE, histogram distribution is utilized to exhibit more concealed inside structure. This will viably help the uniform circulation coordinating by giving more contrast data.

In this work we have introduced two level contrast limited adaptive histogram equalization for enhancement of mammogram images. Instead of using a single desired histogram, this approach employed two different histograms for contrast limited adaptive histogram equalization (CLAHE) in which one CLAHE follows another CLAHE. Compared to CLAHE, transformation function of the proposed technique is monotonic, which is essential for gray level transformation. This new approach is tested on few images of MIAS database and the improved enhancement performance is compared with adaptive histogram equalization (AHE) and histogram equalization (HE).

II. The CLAHE Method

Contrast Limited AHE (CLAHE) [8] encourages the contrast constraining usefulness that makes them not the same as adaptive HE. AHE can upgrade the local subtle elements just while contrast restricting usefulness of CLAHE can improve the global points of interest too. The fundamental favorable position of CLAHE is that it can forestall bends like commotion enhancement which is not in the event of CLAHE. The differentiation restricting usefulness of CLAHE is connected for each neighbor from whom we infer change work.

CLAHE performs noise enhancement by applying contrast constraining usefulness in AHE. The slope of change capacity decides the contrast intensification for each of the pixel esteem and the zone encompassed by pixel esteem. This is like the estimation of histogram for every pixel value. It is additionally like the slope of cumulative distribution function (CDF). CLAHE play out this amplification work by trimming the piece of histogram before applying the CDF which just prompts confine the incline of change. Contingent upon the regularity of this histogram, cut breaking point is the term characterized as the incentive through which histogram is trimmed. Fig 1: shows concept of contrast limited adaptive histogram equalization method.

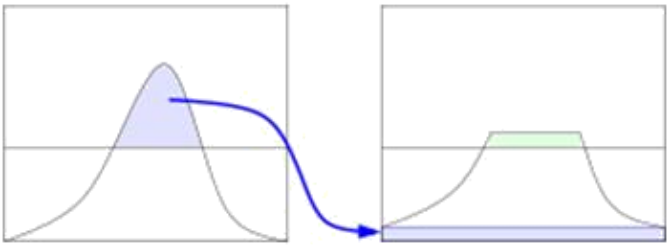

Fig. 1: Concept of Contrast Limited Adaptive Histogram Equalization (source [8]).

III. The Two Stage CLAHE Method

Histogram is the reason for various spatial space image processing methods. Specifically, the part of histogram processing is vital in image improvement. It is sensible to presume that a mammogram image, whose pixels have a tendency to involve the whole scope of conceivable dim levels and moreover, have a tendency to be disseminated consistently will have an appearance of high differentiation and will display an expansive assortment of dim tones. The net impact will be a mammogram image that demonstrates a lot of dark level detail and has high unique range. Give the first information a chance to be X and the histogram evened out image Y. The goal of this method is to create an improved image, which has a superior visual quality than X. This method upgrades the difference of an image in view of CLAHE by mapping the pixel esteems such that the histogram of the subsequent image ends up plainly uniform. It is conceivable to build up a change work that can consequently accomplish this mapping impact, just in view of data accessible in the histogram of the information image. Each canister (parameter of HE) of a histogram in a dim scale image speaks to the quantity of pixels having a similar dim an incentive in the image. It is very successful in improving the difference of mammogram images while AHE orders the uniform utilization of every single dim level. Fig 2: shows flowchart of proposed method.

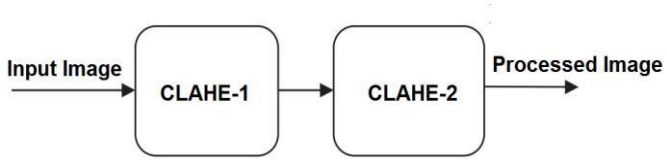

Fig. 2: proposed CLAHE with two levels.

IV. Experimental Results

We have used images of MIAS [7] mammogram image database to check working results our method; and we have used MATLAB built-in functions **histeq** and **adapthisteq** for HE, AHE and CLAHE. For AHE we have set parameter '**ClipLimit**' of **adapthisteq** method to 0.5. Fig. 3 shows working results of two stage CLAHE method with other methods.

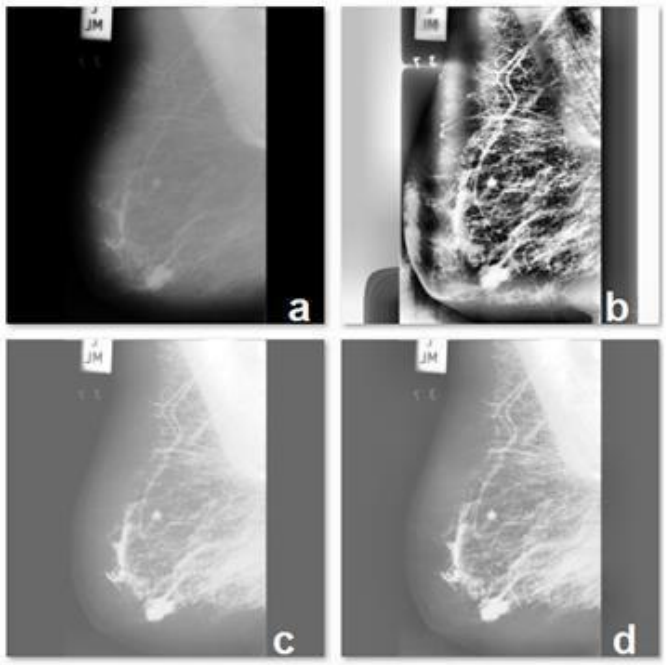

Fig. 3: (a) MIAS mammogram image; (b) two stage AHE result [9] {PSNR=9.220894}; (c) HE result {PSNR=5.946486}; (d) two stage CLAHE result {PSNR=9.572451}.

Working result of Fig 3: show that two-stage-CLAHE method is able to work better than other two standard methods. Also result of two-stage-CLAHE method is having better PSNR value than other methods. At this point one can say that two-stage-CLAHE method is a good choice over other methods for MIAS mammogram image contrast enhancement.

V. Conclusion

This paper presented two level contrast limited adaptive histogram equalization for improvement of mammogram images. Rather than utilizing a single desired histogram, this approach utilized two unique histograms for contrast limited adaptive histogram equalization (CLAHE) in which one CLAHE takes after another CLAHE. Contrasted with CLAHE, change ability of the proposed method is monotonic, which is basic for dim level change. This new approach is tried on images of MIAS database and the enhanced upgrade execution is contrasted and standard AHE and HE.

References

[1]. I.K. Maitra, S. Nag, S.K. Bandyopadhyay, Technique for pre-processing of digital mammogram, Comput. Methods Programs Biomed. 107 (2012) 175-188.

[2]. M. Sundaram, K. Ramar, N. Arumugam, G. Prabin, Histogram modified local contrast enhancement for mammogram images, Appl. Soft Comput. 11 (2011) 5809-5816.

[3]. T. Celik, T. Tjahjadi, Contextual and variational contrast enhancement, IEEE Trans. Image Process. 20 (2011) 3431-3441.

[4]. J.H. Han, S. Yang, B.U. Lee, A novel 3 -D color histogram equalization method with uniform 1-D gray scale histogram, IEEE Trans. Image Process. 20 (2011) 506-512.

[5]. Y.R. Lai, K.L. Chung, G.Y. Lin, C.H. Chen, Gaussian mixture modelling of histograms for contrast enhancement, Expert Syst. Appl. 39 (2012) 6720-6728.

[6]. K. Panetta, Y. Zhou, S. Agaian, H. Jia, Nonlinear unsharp masking for mammogram enhancement, IEEE Trans. Inf. Technol. Biomed. 15 (2011) 918-928.

[7]. The mini-MIAS database of mammograms, http://peipa.essex.ac.uk/info/mias.html

[8]. K Zuiderveld. "Contrast Limited Adaptive Histogram Equalization." *Graphic Gems IV*. San Diego: Academic Press Professional, 1994. 474–485.

[9]. S. Anand, S. Gayathri, "Mammogram image enhancement by two-stage adaptive histogram equalization", Optik 126 (2015) 3150–3152