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Biomedical Image brightness preservation and segmentation technique using CLAHE and Wiener filtering

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Abstract: In biomedical image processing, low contrast image analysis is a challenging problem. Low contrast digital images reduce the ability of observer in analyzing the image. Image enhancement and information extraction are two important components of biomedical image processing. Image enhancement techniques help in improving the visibility of any portion or feature of the image. The most effective method used for contrast enhancement is Histogram Equalization (HE). Here propose a new method named "Biomedical Image brightness preservation and segmentation technique using CLAHE and Wiener filtering". Here use CLAHE and Wiener filtering based techniques to enhance contrast of biomedical images. The contrast of an image is enhanced by applying CLAHE on small data regions called tiles rather than the entire image. Wiener filtering reduces the content of noise in histogram equalized image.

Keywords: Biomedical Image Enhancement, CLAHE, Wiener filtering, Contrast Enhancement.

I. INTRODUCTION

Contrast enhancement is an important area in the field of biomedical digital image processing for human visual perception and computer vision. Histogram Equalization (HE) method is one such technique used for contrast enhancement which improving visual quality of low contrast images [1].

Biomedical image enhancement is one of the most important images processing technology which is necessary to improve the visual appearance of the image or to provide a better transform representation for future automated image processing such as image analysis, detection, segmentation and recognition [2]. Many images have very low dynamic range of the intensity values due to insufficient illumination and therefore need to be processed before being displayed. This proved as a flexible and effective way for medical image enhancement and can be used as a pre-processing step for medical image understanding and analysis.

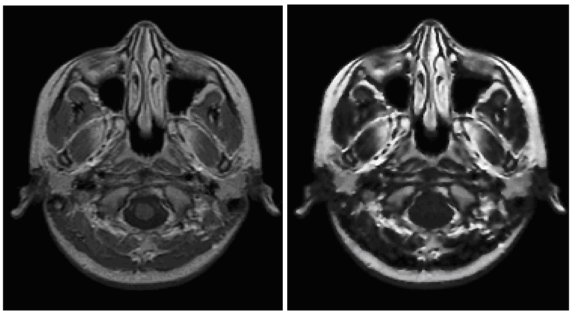

Fig.1: An image enhancement example.
(a) Original image with low contrast;
(b) enhanced image with higher contrast.

Fig.1 shows an example of enhancing an MRI image, where some details in the image become more obvious after enhancement (Fig.1 (b)).

Contrast enhancement techniques are of particular interest in photography, satellite imagery, medical applications and display devices. Producing visually natural is required for many important areas such as vision, remote sensing, dynamic scene analysis, autonomous navigation, and biomedical image analysis [3]. Histogram Equalization (HE) method is one such technique use to improve the brightness in image so that it will reduce the number of gray levels in image.

II. LITERATURE REVIEW

Extensive research has been done on image enhancement and hence it has become essential to classify the research outcomes and provide an overview of the available enhancement techniques. In this chapter different image enhancement techniques with their conceptual details are reviewed. The wide categorization of the reviewed algorithms is brought out with the emphasis on the state of art research in each category.

Wei Fan, Kai Wang, Francois Cayre, and Zhang Xiong [1] proposed an image variational deconvolution framework for both quality enhancement and antiforensics of median filtered images. The proposed optimizationbased framework consists of a convolution term, a fidelity term with respect to the median filtered image, and a prior term. The first term is for the approximation of the median filtering process, using a convolution kernel. The second

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fidelity term keeps the processed image to some extent still close to the median filtered image, retaining some denoising or other image processing artifact hiding effects.

Hongteng Xu, Guangtao Zhai, Xiaolin Wu, and Xiaokang Yang [3] proposed a generalized equalization model for image enhancement. Based on analysis on the relationships between image histogram and contrast enhancement/ white balancing, first establish a generalized equalization model integrating contrast enhancement and white balancing into a unified framework of convex programming of image histogram. They show that many image enhancement tasks can be accomplished by the proposed model using different configurations of parameters. With two defining properties of histogram transform, namely contrast gain and nonlinearity, the model parameters for different enhancement applications can be optimized.

Tarun Kumar Agarwal, Mayank Tiwari, Subir Singh Lamba [6] proposed a method named “Modified Histogram Based Contrast Enhancement using Homomorphic Filtering" (MH-FIL) for medical images. This method uses two step processing, in first step global contrast of image is enhanced using histogram modification followed by histogram equalization and then in second step homomorphic filtering is used for image sharpening, this filtering if followed by image normalization. To evaluate the effectiveness of method choose two widely used metrics Absolute Mean Brightness Error (AMBE) and Entropy.

David Menotti, Laurent Najman, Jacques Facon, Arnaldo de A. Araujo and Gisele L. Pappa [11] proposed two methodologies for fast image contrast enhancement based on histogram equalization (HE), one for gray-level images, and other for colour images. For gray-level images, they propose a technique called Multi-HE, which decomposes the input image into several sub-images, and then applies the classical HE process to each one of them. In order to decompose the input image, we propose two different discrepancy functions, conceiving two new methods. Experimental results show that both methods are better in preserving the brightness and producing more natural looking images than other HE methods. For colour images, they introduce a generic fast hue-preserving histogram equalization method based on the RGB colour space, and two instantiations of the proposed generic method, using 1D and 2D histograms.

Oakar Phyo, AungSoe Khaing [8] presented the mathematical morphology method to detect and eliminate the optic disc (OD) and the blood vessels. Detection of optic disc and the blood vessels are the necessary steps in the detection of diabetic retinopathy because the blood vessels and the optic disc are the normal features of the retinal image. And also, the optic disc and the exudates are the brightest portion of the image. Detection of optic disc and the blood vessels can help the ophthalmologists to detect the diseases earlier and faster. Optic disc and the blood vessels are detected and eliminated by using mathematical morphology methods such as closing, filling, morphological reconstruction.

III. PROPOSED SYSTEM

With the fast advance of technologies and the prevalence of imaging devices, billions of biomedical digital images are being created every day. Due to undesirable light source, failure of the imaging device itself, the contrast and tone of the captured image may not always be satisfactory. Therefore, image enhancement is required. In medical image processing, low contrast image analysis is a challenging problem. Low contrast digital images reduce the ability of observer in analysing the image. Here use CLAHE and Wiener filtering based techniques to enhance contrast of biomedical images. These methods are use to find exact locations of cancerous regions and for low-dose CT images, these methods are use to intensify tiny anatomies like vessels, lungs nodules, airways and pulmonary fissures. Here propose a new method named “Biomedical Image brightness preservation and segmentation technique using CLAHE and Wiener filtering”. In propose method, apply HE method for contrast enhancement on modified histogram i.e. Contrast Limited Adaptive Histogram Equalization (CLAHE), after that use wiener filtering for image sharpening and then to minimize the difference between input and processed image mean brightness. The method has the ability to control the level of contrast enhancement in the output image.

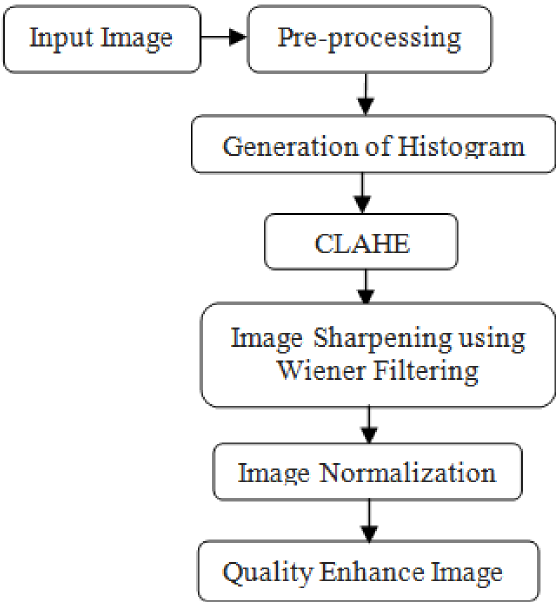

Fig. 2: Shows functional block diagram to preserve brightness and segmentation technique using CLAHE and Wiener filtering.

A. Generation of Histogram

The histogram of an image is the graphical representation of the comparative frequencies of the different gray levels in the image. It provides a total description of the appearance of an image.

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Equalization implies mapping from given intensity distribution to uniform intensity distribution (a wider and more flat distribution of intensity values) so the intensity values are spread over the whole range. Through this adjustment, we can achieve close to equally distributed intensities in an output image.

B. Contrast Limited Adaptive Histogram Equalization (CLAHE)

The CLAHE algorithm is a widely use technique which results in contrast enhancement of medical images. The histogram is cut at some threshold and then equalization is applied. It is adaptive contrast histogram equalization method, where the contrast of an image is enhanced by applying CLAHE on small data regions called tiles rather than the entire image. The resulting neighbouring tiles are then stitched back seamlessly using bilinear interpolation. The contrast in the homogeneous region can be limited so that noise amplification can be avoided. While performing AHE if the region being processed has a relatively small intensity range then the noise in that region gets more enhanced. It can also cause some kind of artifacts to appear on those regions. To limit the appearance of such artifacts and noise, a modification of AHE called Contrast Limited AHE can be used.

The only difference between regular AHE and CLAHE is that there is one extra step to clip the histogram before the computation of its CDF as the mapping function is performed. Hence CLAHE is implemented in the same function tiled AHE in ahe.cpp. The program "ahe" takes an additional optional parameter which specifies the level at which to clip the histogram. By default no clipping is performed.

Following is the overview of the algorithm for this function:

1. Calculate a grid size based on the maximum dimension of the image.
2. If a window size is not specified chose the grid size as the default window size.
3. Identify grid points on the image, starting from top left corner. Each grid point is separated by grid size pixels.
4. For each grid point calculate the histogram of the region around it, having area equal to window size and centred at the grid point.
5. If a clipping level is specified clips the histograms computed above to that level and then use the new histogram to calculate the CDF.
6. After calculating the mappings for each grid point, repeat steps 6 to 8 for each pixel in the input image.
7. For each pixel find the four closest neighbouring grid points that surround that pixel.
8. Using the intensity value of the pixel as an index, find its mapping at the four grid points based on their cdfs.
9. Interpolate among these values to get the mapping at the current pixel location. Map this intensity to the range [min:max) and put it in the output image.

C. Wiener Filtering

In general, enhancement in contrast also leads to enhancement of noise in some visually important areas, hence we are applying Wiener filtering to reduce the content of noise in histogram equalized image.

Wiener filtering is a method use to enhance or restore the degraded images having uneven illumination. This technique uses illumination-reflectance model in its operation [5]. Weiner filtering is a stochastic framework for restoring images in the presence of blur as well as noise.

The Wiener filtering is optimal in terms of the mean square error; it minimizes the overall mean square error in the process of inverse filtering and noise smoothing. The Wiener filtering is a linear estimation of the original image.

$$y(\omega_1,\omega_2) = h(\omega_1,\omega_2)*x(\omega_1,\omega_2) + u(\omega_1,\omega_2)$$

where * is 2D convolution, $h(\omega_1,\omega_2)$ is the point spread function (PSF), $x(\omega_1,\omega_2)$ is the original image, and $u(\omega_1,\omega_2)$ is noise. The orthogonality principle implies that the Wiener filter in Fourier domain can be expressed as

$$W(\omega_1,\omega_2) = \frac{H^*(\omega_1,\omega_2)\, S_{xx}(\omega_1,\omega_2)}{\left| H(\omega_1,\omega_2) \right|^2 S_{xx}(\omega_1,\omega_2) + S_{\eta\eta}(\omega_1,\omega_2)}$$

Where $S_{xx}(\omega_1,\omega_2)$ $S_{\eta\eta}(\omega_1,\omega_2)$ are respectively power spectra of the original image and the additive noise, and $H(\omega_1,\omega_2)$ is the degradation function. It is easy to see that the Wiener filter has two separate parts, an inverse filtering part and a noise smoothing part. It not only performs the deconvolution but also removes the noise by lowpass filtering.

To implement the wiener filter in practice, the power spectra of the original image and the additive noise should be known. A constant estimate of the ratio of the power spectra is not always a suitable solution. Inspite of its great potentiality, wiener filter does not compensate for phase distortions due to noise in the observations.

IV. RESULT ANALYSIS

Image enhancement aims at producing images with improved brightness/contrast and detail, so as to better represent the visual information. It is widely used in many areas, such as vision, remote sensing, dynamic scene analysis, autonomous navigation and biomedical image analysis. Matlab is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numeric computation. In addition to the intellectual property functions provided in Matlab, the software packet is uniquely adept with vector and array based waveform data at the core of algorithms, which is suitable for applications such as image and video processing. Here use

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the MATLAB R2013a version and biomedical images, X-rays, MRI and CT scans as database.

Result on images

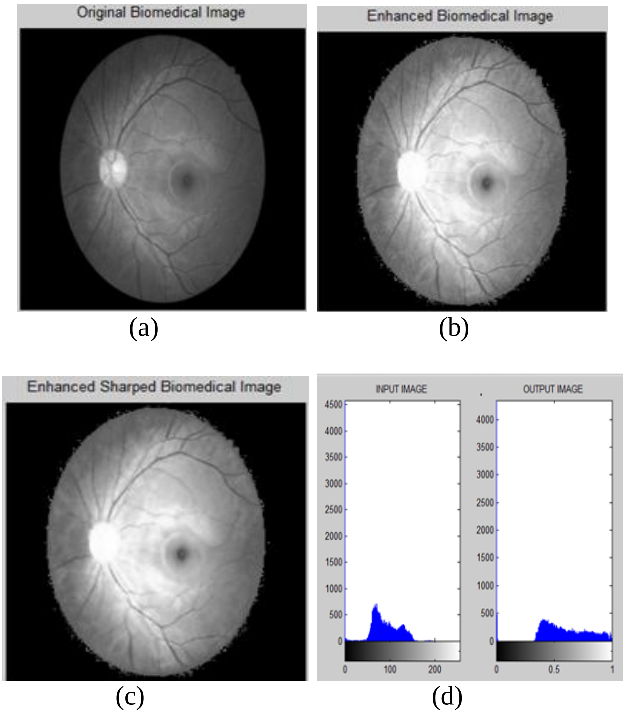

Fig.3: Image I (a) Original image
(b) Enhanced Biomedical Image
(c) Enhanced Sharped Biomedical Image
(d) Histogram of image

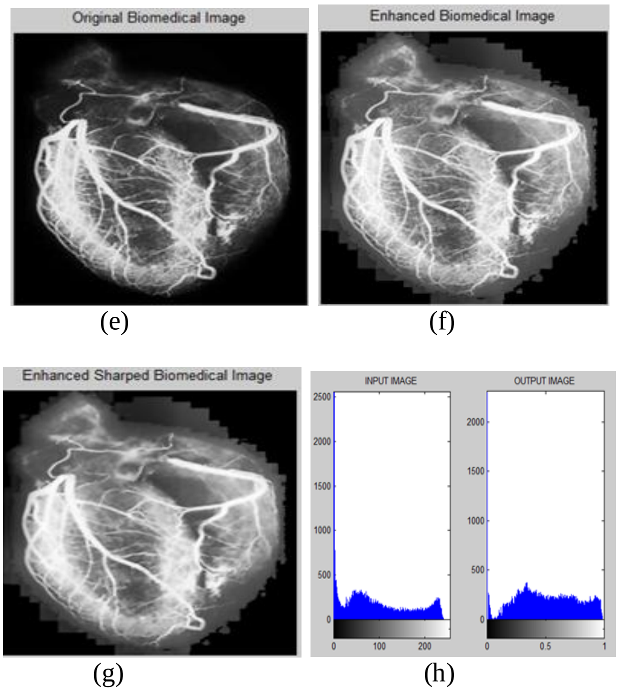

Fig.4: Image II (e) Original image
(f) Enhanced Biomedical Image
(g) Enhanced Sharped Biomedical Image
(h) Histogram of image

TABLE I: Performance Parameters

Sr. No.	Images	PSNR	RMSE	Correlation	Execution Time
1	Image I	38.8442	8.4852	0.9852	539.8924
2	Image II	38.0975	10.0770	0.9326	308.4845

V. CONCLUSION

Image enhancement is one of the challenging issues in low level image processing. The low contrast, nosy and blur images are enhanced by using different filtering techniques and contrast enhancement techniques. The CLAHE and Wiener filtering provides optimum contrast enhancement while preserving the brightness of given medical image and suitable for all types of medical images. Wiener filter is suitable for image sharpening and CLAHE is good for increase the contrast of the image. These methods help to doctors and radiologist for correct diagnosis of the desieses at an earliest.

REFERENCES

[1] Wei Fan, Kai Wang, Francois Cayre and Zhang Xiong, "Median Filtered Image Quality Enhancement and Anti-Forensics via Variational Deconvolution," IEEE TRANSACTIONS ON INFORMATION FORENSICS AND SECURITY, pp. 1-16, 2015.

[2] Vikrant Bhateja, Gopal Singh, Atul Srivastava and Jay Singh, "Speckle Reduction in Ultrasound Images Using an Improved Conductance Function Based on Anisotropic Diffusion," International Conference on Computing for Sustainable Global Development (INDIACom), pp. 619-624, 2014.

[3] Hongteng Xu, Guangtao Zhai, Member, Xiaolin Wu, Fellow, and Xiaokang Yang, "Generalized Equalization Model for Image Enhancement," IEEE TRANSACTIONS ON MULTIMEDIA, VOL. 16, NO. 1, pp. 68-82, 2014.

[4] Gagandeep Singh and Sarbjeet Singh, "An Enhancement of Images Using Recursive Adaptive Gamma Correction," Gagandeep Singh et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 6 (4) , pp. 3904-3909, 2015.

[5] Aziz Makandar and Bhagirathi Halalli, "Breast Cancer Image Enhancement using Median Filter and CLAHE," International Journal of Scientific & Engineering Research, Volume 6, Issue 4, pp. 462-465, 2015.

[6] Tarun Kumar Agarwal, Mayank Tiwari and Subir Singh Lamba, "Modified Histogram Based Contrast Enhancement using Homomorphic Filtering for Medical Images," International Advance Computing Conference (IACC), pp. 964-968, 2014.

[7] Mandeep Kaur and Ishdeep Singla, "A Dualistic Sub-Image Histogram Equalization Based Enhancement and Segmentation Techniques with NN for Medical Images," Research Inventy: International Journal Of Engineering And Science Vol.05, Issue 01, PP: 15-19, 2015.

[8] Oakar Phyo and AungSoe Khaing, "AUTOMATIC DETECTION OF OPTIC DISC AND BLOOD VESSELS FROM RETINAL IMAGES USING IMAGE PROCESSING TECHNIQUES," IJRET: International Journal of Research in Engineering and Technology, Volume: 03 Issue: 03, pp. 300-307, 2014.

[9] Chahat Chaudhary and Mahendra Kumar Patil, "REVIEW OF IMAGE ENHANCEMENT TECHNIQUES USING HISTOGRAM EQUALIZATION," International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 2, Issue 5, pp. 343-349, 2013.

[10] 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, pp. 11-25, 2013.

[11] David Menotti, Laurent Najman, Jacques Facon, Arnaldo de A. Araujo and Gisele L. Pappa, "Contrast Enhancement in Digital

Imaging using Histogram Equalization," Phd thesis, submitted to the Department of Computer Science, UFMG- Universidade Federal de Minas Gerais, 2008.
[12] Y. Toufique, R. Cherkaoui El Moursli, Lh. Masmoudi, A. El Kharrim, M. Kaci, S. Allal, "Ultrasound Image Enhancement Using An Adaptive AnisotropicDiffusion Filter", 2014 Middle East Conference on Biomedical Engineering (MECBME) February 17-20, pp. 1-4, 2014.
[13] Qadar Muhammad Ali, Zhaowen Yan and Hua Li, "Iterative Thresholded Bi-Histogram Equalization for Medical Image Enhancement", International Journal of Computer Applications (0975 – 8887) Volume 114 – No. 8, pp. 20-27, March 2015.
[14] Shanmugavadivu Pichai, Balasubramanian Krishnasamy, and Somasundaram Karuppanagounder, "Bi-Level Weighted Histogram Equalization for Scalable Brightness Preservation and Contrast Enhancement for Images", The International Arab Journal of Information Technology, Vol. 10, No. 6, pp. 603-609, November 2013.
[15] G.Nandin1, P. Pradeep Raju, R. Lavanya, "IMAGE ENHANCEMENT USING HYBRID TRANSFORMATION TECHNIQUES", IJRET: International Journal of Research in Engineering and Technology, Volume: 04 , Special Issue: 12 , pp.101-104, Oct-2015.

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