Histogram Equalization for Image Enhancement Using MRI brain images

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***Abstract*—- Medical image processing plays an essential role in providing information in wide area for such advanced images. Magnetic resonance imaging (MRI) is an advanced medical imaging technique providing rich information about the human soft tissue anatomy. MRI of the brain is an invaluable tool to help physicians to diagnose and treat various brain diseases including stroke, cancer, and epilepsy. The specific information to evaluate the diseases. Histogram equalization is one of the important steps in image enhancement technique for MRI. There are several methods of image enhancement and each of them is needed for a different type of analysis. In this paper study and compare different Techniques like Global Histogram Equalization (GHE), Local histogram equalization (LHE), Brightness preserving Dynamic Histogram equalization (BPDHE) and Adaptive Histogram Equalization (AHE) using different objective quality measures for MRI brain image Enhancement.**

Keywords- *Medical image processing, MRI brain image, Contrast enhancement, Histogram equalization*

I. INTRODUCTION

Image processing is a vast and demanding area and applications used in various fields like medical images, satellite images and also in industrial applications [1]. In our human senses eye is the most powerful sense. Obtaining and exploring images are forms a huge part of the habitual cerebral activity of human beings in their whole life time. The human brain is engaged in processing images from the image cortex [10]. MRI of brain is an easy and effortless test that used to create in depth images of the brain. MRI machines that have bigger opening are useful for patients. MRI machines are situated in many hospitals and radiology centers. MRI of brain is able to evaluating problems easily such as persistent pain and weak points, and helps us to notice positive result for the patient.

The main function of image enhancement is to carry out the hidden part in an image or to enhance the low contrast image. The quality of the image gets better by contrast manipulation. A very well-liked performance for contrast enhancement is Histogram Equalization (HE). The most part of techniques is used, due to simplicity and moderately better performance on images [1].

The main objective of this work is to study and compare the Histogram Equalization basic methods like Global Histogram Equalization (GHE), Local histogram equalization (LHE), Brightness preserving Adaptive Histogram Equalization (AHE) and Dynamic Histogram equalization (BPDHE) using different objective quality measures for MRI brain image Enhancement.

This paper is organized as follows. Section II Introduces about the brain image Enhancement. Section III discuss about the Histogram Equalization Techniques. In this Technique some basic Techniques and the equations are explained. Section IV deal with Measurement of HE. Sections V discuss the Analysis of experiments and results for HE, the diagrams displays the Histogram Equalization for all the methods. Finally, Section VI presents the conclusion.

II. BRAIN IMAGE ENHANCEMENT

Digital Image Processing (DIP) engages the modification of digital data for improving the image qualities with the aid of computer. The processing helps in maximizing clearness, sharpness and details of features of attention towards Information extraction and further analysis.

MRI is an experiment that applies a magnetic field with pulse of radio wave force to obtain pictures in the head. The diagnostic method that applies a mixture of a large magnet, radiofrequencies, and then the processor to create complete images of organs also structures in the body, which used to find flow of blood and also find the bleeding in the brain, and find the injury in the head. In below diagram "Fig.1" shows the MRI brain image [12][11].

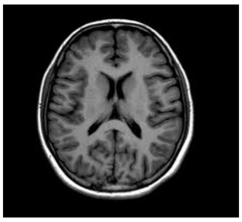

Figure 1. MRI brain image

Enhancement is the alteration of an image to adjust impact on the viewer. Generally enhancement alters the original digital values to bring out specific features of an image, and Highlight the certain characteristics of an image. The processed image is more suitable than the original image for a particular application. In the below diagram "Fig.2" shows the Histogram Equalization.

The classical contrast enhancement is Histogram Equalization (HE), which has good performance for ordinary images, such as human portraits or natural images.

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Transformation or mapping of each pixel of input image into corresponding pixel of processed output image is called Histogram Equalization [1].

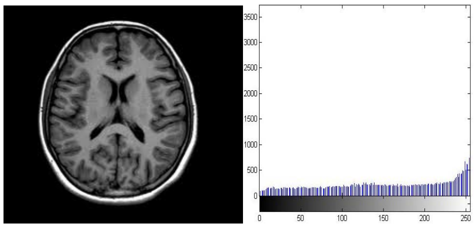


Figure 2. Histogram equalization for MRI brain image

III. HISTOGRAM EQUALIZATION TECHNIQUES

Histogram Equalization (HE) and their complex methods are measured for contrast enhancement of the images. In this paper discuss about some techniques in HE.

A. Histogram Equalization (HE)

Histogram equalization is a technique for adjusting image intensities to enhance contrast. The histogram of an image mostly represents the comparative frequency of occurrence of the various gray levels in the image [3].

$$\mathrm{p_n} = \frac{\text{no. of pixels with intensity } \mathrm{n_k}}{\text{total no. of pixels n}} \; n = 0,1..L-1$$

Consider an image with gray levels in the *range [0, L −1]*, Probability Distribution Function of the image can be computed as:

$$p_{(r_k)} = \frac{n_k}{n} \; n = 0,1,...L-1$$

Where, r_k is the k^{th} gray level and n_k is the number of pixels in the image having gray level r_k.

Histogram Equalization (HE) method has two main disadvantages which affect efficiency of this method [1]. Histogram Equalization (HE) assigns one gray level into two different neighbor gray levels with different intensities. If most of an image includes a gray level, Histogram Equalization (HE) assign a gray level with higher intensity to that gray level and gives washed out appearance to the resultant image [1]. HE can initiate a considerable change in brightness of an image obtain a maximum value of the uniformly distributed image.

B. Global Histogram Equalization (GHE)

This is a histogram technique which acquires the input image given by the user and enhances the image globally and displays both the initial and final images [5]. GHE offer a significant progress in image contrast.

Contrast of images is resolute in dynamic range, which is defined as the ratio among the brightest and the darkest pixel intensities. The histogram offers information for the contrast and overall intensity distribution of an image [2].

The input image f(x,y) collected of discrete gray levels in the dynamic range [0, L-1]. The transformation $C(r_k)$ is defined as

$$s_k = c_{(r_k)} = \sum_{i=0}^{k} p_{(r_i)} = \sum_{i=0}^{k} \frac{n_i}{n}$$

Where, $0 \le S_k \le 1$ and $k = 0, 1, 2, ... L-1$. In (1), 'n_i' stands for the number of pixels contain gray level 'r_i', 'n' is the total number of pixels in the input image, and $P(r_i)$ stands for as the Probability Density Function (PDF) of the input gray level 'r_i'. Based on the PDF, the Cumulative Density Function (CDF) is defined as $C(r_k)$. This mapping is called Global Histogram Equalization (GHE). Here 'S_k' can simply be mapped to the dynamic range of *[0, L-1]* multiplying by *(L-1)*. The result of HE is improved the image contrast. However, representation has not natural look because of in excess of enhancement in clarity [2].

C. Local Histogram Equalization (LHE)

While GHE takes into description the global information and cannot adjust the local light condition. Local Histogram Equalization (LHE) carries out block-overlapped histogram equalization. LHE classify a sub-block and recovers the information [4]. Then, the histogram equalization is useful for the center pixel used in the CDF of the sub-block. Now, the sub-block is stimulated by one pixel and the sub-block histogram is repeated until the image achieve. LHE cannot get used to well partial brightness in sequence, still more enhances some section depends on size of the mask [2].

D. Adaptive Histogram Equalization (AHE)

Adaptive Histogram Equalization (AHE) is a terrific contrast enhancement method for both Natural images and Medical images. The method engages applying to each pixel in HE [7]. Histogram equalization is classified into two categories: non adaptive and adaptive. In the non adaptive each pixel is customized by applying the same pattern of calculation that uses the histogram of complete original image. In works with better result for images that has details hidden in dark regions [6].

In the adaptive each pixel is customized based on the pixels that are in a region neighboring that pixel. This region is called contextual region. If an image of *n x n* pixels, with *k* intensity levels and the size of contextual region is *m x m*, then the time required for calculations is $O(n^2(m + k))$. Better results are obtained through instead use of the histogram of neighborhood pixels from a moving window only four nearest grid points [6].

$$a = \frac{y - y_-}{y_+ - y_-}, b = \frac{x - x_-}{x_+ + x_-}$$

E. Brightness Preserving Dynamic Histogram Equalization (BPDHE)

The brightness preserving dynamic histogram equalization (BPDHE), is also an expansion to HE they can create the Output image by mean intensity that is almost the same to the input mean intensity. The conditions maintain the brightness of the image [8].

IV. MEASUREMENT OF HISTOGRAM EQUALIZATION

Every above method is compared by statistical point of view by using some standard quality measures.

A. Weber contrast

The Weber contrast is defined as

$$\frac{L_{\max} - L_{\min}}{L_{\max}}$$

With L and L_b shows the luminance of the fields and the background, respectively. They normally used in small fields on a large uniform background.

B. Michelson contrast

The Michelson contrast is normally used for model is both bright and dark features are equal and take up related portion of the region.

$$\frac{l_{\max} - l_{\min}}{l_{\max} + l_{\min}}$$

Where, I_{max} & I_{min} – maximum and minimum intensities in an image. This value should be 1 which proves that total range of image is maintained constant [1] .

C. Contrast

Contrast is mentioned as ratio, such at 3:1. An N:1 relation means that separating the brighter luminance with the darker luminance provide a number that is the same to N.

$$c_r = \frac{y_{\max}}{y_{\min}}$$

Were display systems, contrast relations are white: black and highly magnified by neglecting the impact of ambient illumination in usual viewing environments [9].

D. AMBE

AMBE is defined as the difference between the input and output mean. The expression for AMBE may be given as

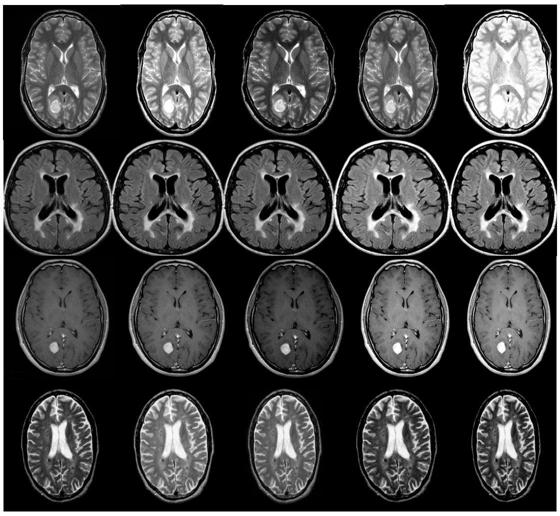
$$AMBE = | E(x) - E(y) |$$

Where, $E(x)$ is the mean of the input image, $E(y)$ is the mean of the output image. A median value implies better brightness preservation [9].

V. ANALYSIS OF EXPERIMENTS AND RESULTS FOR HISTOGRAM BRAIN IMAGE

In this paper, study and compare histogram based approach for contrast enhancement. The good contrast image is useful for detail analysis and diagnosis. This contrast is measured with different objective quality metrics. All the above methods are applied on different brain MRI images. In below diagram “Fig.3” shows the HE images and “Fig.4” shows the corresponding images for HE, “Fig.5” refers the HE graph images. “Table.1” shows the different metrics and values. The proposed images without making any loss in image information.

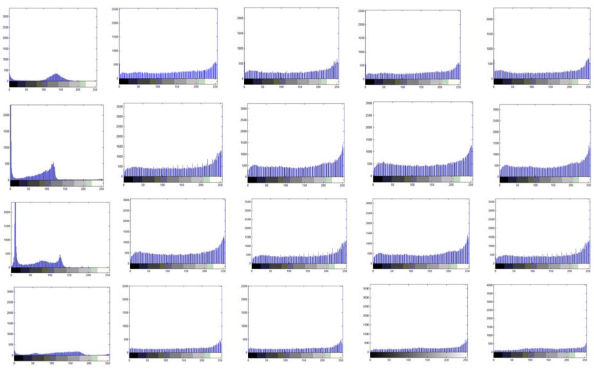
A. Histogram brain Images



(a) (b) (c) (d) (e)

Figure 3. Histogram Brain Images (a) Original image, (b) Using GHE, (c) Using LHE, (d) Using AHE, (e) Using BPDHE

B. Histogram Equalization



(a) (b) (c) (d) (e)

Figure 4. Histogram Images corresponding to Fig.3 (a) Original image, (b) Using GHE, (c) Using LHE, (d) Using AHE, (e) Using BPDHE

C. *Quality Measures*

TABLE I. EXPERIMENTAL RESULTS

Methods	Weber contrast	Michelson contrast	AMBE	Contrast
GHE	0.6532	0.3452	81.251	24.4265
LHE	0.7524	0.4213	84.524	23.846
AHE	0.5231	1	0.4821	31.254
BPDHE	0.6245	0.7254	27.541	34.456

D. *Histogram Equalization graph*

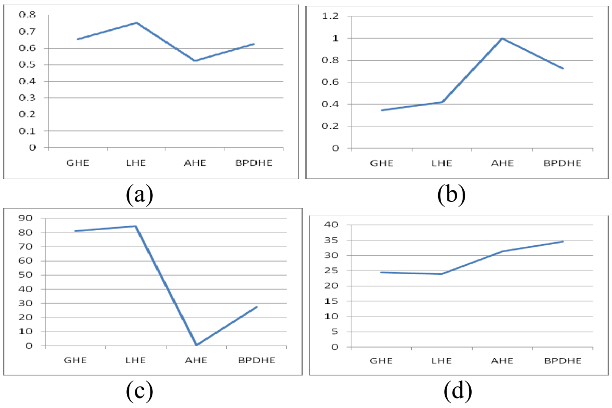


Figure 5. HE graphs corresponding to Table.1 (a) Weber Contrast, (b) Michelson Contrast (c) AMBE (d) Contrast

VI. CONCLUSION

In this work, image histogram based enhancement equalization methods are compared for particular enhancement like contrast of MRI brain image. More popular HE methods like GHE, LHE, AHE and BPDHE are compared and some of MRI image data sets and obtained results from the HE methods are processed under the Quality metrics and results are analyzed.

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