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An Effective Method for Histogram Equalization based MRI Brain Images Contrast Enhancement

Dr. Sana'a Khudayer Jadwaa

Support Sciences Unit, Al-Nahrain University/College of Medicine
Baghdad-Iraq
Email: sanaakhudayer@ced.nahrainuniv.edu.iq

Abstract:

Medical images, for instance X-ray or MRI images used to create extraordinary quality images of human body. It provides detail facts to explore the diseases. The image processing for medical images plays vital role to provide information in more extent for such advance images. MRI or X-ray images are in general having low contrast, it is very difficult for doctors to analyze them, so the image enhancement for medical image become very important subject in the medicine filed .This paper present an effective, simple and fast method to enhance MRI brain image by increasing the contrast of an image using the Histogram Equalization (HE) technique. The experimental results show the effectiveness of this method.

Keywords —: **Image Histogram, Histogram Equalization, Medical Image, Image Enhancement , Contrast Enhancement.**

I. INTRODUCTION

Image processing for medical image is one of the most interesting areas in research field. MRI (magnetic resonance imaging), CT (Computed Tomography) scan imaging are the most vital for image based visual diagnostics in medical field [1]. A lot of images like satellite images, medical images, real-life photographs and aerial images may suffer from number of degradations; poor contrast due to poor illumination or limited sensitivity of the imaging device and electronic sensor noise or atmospheric disturbances leading to wide band noise [2]. Now a day, the request for enhancement of medical images has been increased in order to help doctors to make correct diagnosis so medical image processing provides an assistance to improve the medical images for accurate diagnosis of disease. Images quality improvement becomes one of the significant tasks of medical image processing [3].In many applications of digital image processing filed, the image contrast enhancement plays a vital role like medical imaging, face recognition ,and satellite imaging [4]. The techniques of contrast enhancement have many application fields such as in medical imaging in order toimprove the visual quality of low image's contrast . It is aessential step for analyzing the medical image for emphasizing the vital features or the features that are not correctly visible[5]. For both human and computer vision contrast enhancement is an important area in image processing. It is generally used for processing of medical images and as a pre-processing step in texture synthesis, speech recognition, and several other image/video processing applications [6]. The most popular and widely used contrast enhancement technique is the histogram equalization due to its accuracy and easy

implementation. This technique compresses the probability distributions and increases contrast of an input image by extending the dynamic range of gray levels. However, it does not contribute to improve the local contrast of an image since it only uses the global information [4]. One of the most acceptable methods for medical images enhancement is contrast enhancement. There are many contrast enhancement techniques i.e. Histogram Equalization, Linear Stretch, Region based enhancement, Convolution mask enhancement, and Adaptive enhancement are already existing. Select of technique depends on features of image [7]. This paper deals with contrast enhancement using the histogram equalization for enhancement the medical images. The organization of the rest of this paper is as follows. Section 2 highlights the related works. Section 3 introduces image contrast enhancement. Section 4 describes the histogram equalization. Section 5 present the proposed method .The experimental results presented in section 6 and section 7 concludes the paper.

II. Related Works

Many techniques for medical image enhancement were applied by various researchers in order to improve the visual form of an image to be appropriate for analysis. [8] Proposed a new image enhancement technique built on M band wavelets. The straight image enhancement processes opt for contrast enhancement using equalization techniques. The proposed algorithm involves of 3 steps, first step includes of resolution enhancement, the second step involves of de-noising of image and finally, stage three involves of contrast enhancement. [9] In this study, the morphological transform procedure is carried out on medical images to improve the quality and contrast. A disk shaped mask is used in Top-Hat and Bottom-Hat transform and this mask plays a vital role in the operation. Many types and sizes of medical images require different masks so that they can be effectively enhanced. The technique shown in this study takes a mask of a random size and retains changing its size until a best enhanced image is gained from the transformation operation. [10] They proposed bi histogram Bezier curve contrast enhancement introduces the idea of “adequate contrast enhancement” to overcome quick jump problem in knee MRI. Since each image creates its own intensity distribution, the adequate contrast enhancement checks on the image's maximum intensity distortion and uses intensity discrepancy reduction to generate Bezier transform curve. The proposed method expands tissue contrast and preserves pertinent knee features without compromising natural image appearance. Besides, statistical results from Fisher's Least Significant Difference test and the Duncan test have consistently indicated that the proposed method outperforms fundamental contrast enhancement methods to exalt image visual quality. [11]they proposed an adaptive procedure for brain MRI images called the hierarchical correlation histogram analysis algorithm (HCHA). HCHA can automatically improve three types of major PD-affected brains atrophic cells in images. This algorithm uses each object’s grayscale distribution degree of pixel intensity to construct a correlation histogram matrix from the original ROI. Then, it generates a segment of the correlation histogram matrix wherein different blocks express the correlation distribution degree of each object, since the specific objects cannot be represented in the global correlation histogram. The hierarchical analysis focuses on particular objects to represent the correlation distributions of pixels for optimization and adaptively regulates the contrast of each specific object.

III. Image Contrast Enhancement

In each field where images are have to be analysed and understood the image enhancement is applied. For example, analysing of medical images, analysis of images from satellites etc. The meaning of image enhancement is transforming an image f into image g using T. (Where T is the transformation). In images f and g the values of pixels are denoted by r and s , respectively. As said, the pixel values r and s are related by the equation(1) [12]:

$$s = T(r) \dots \dots \dots (1)$$

Where T is a transformation that maps a pixel value r into a pixel value s . The outcomes of this transformation are mapped into the grey scale range .So, the outcomes are mapped back into the range [0,L-1], where L = 2k, k being the number of bits in the image being considered. So, for instance, for an 8-bit image the range of pixel values will be [0,255][12]. Contrast enhancement is often denoted to as one of the most essential issues in image processing .The contrast stretching idea means increasing the dynamic range of gray levels in the image being processed. The two digital techniques Linear and nonlinear are commonly practiced methods of increasing the contrast of an image[13].

IV. HISTOGRAM EQUALIZATION

Histogram Equalization (HE) is one of the most common image enhancement method, because of the simplest and effectiveness of the HE, it becomes a popular technique for contrast enhancement. In many fields such as in medical image processing, sonar image processing and radar image processing, HE technique can be applied. The idea of HE method is to re-map the gray levels of an image based on the image's gray levels (CDF) cumulative density function. The dynamic range of the resultant image histogram is flattening and stretching by HE and as a consequence, it enhances the contrast of the image and gives an overall contrast improvement [14]. The histogram as shown in fig. 1, is defined as a graph that viewing the number of pixels in an image for each intensity level in the image. For example ,an 8 bit grayscale image there are 0-255 intensity levels so the histogram will graphically show 0-255 numbers on X-axis and number ofoccurrences of an intensity level in image correspondingly .

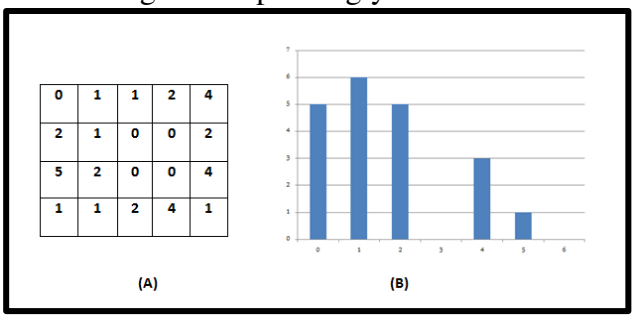

Fig. 1 : Diagram for image's histogram. (A) Theimage, (B) image's histogram.

In the image histogram the horizontal axis represents the tonal variations, while number of pixels in that particular tone represents by the vertical axis. Black and dark areas represented by the left side of the horizontal axis, the middle represents medium grey and the light and pure white areas are represented by the right hand side of the horizontal axis [15].Histogram equalization (HE) technique is widely used predominantly due to rapidity and simplicity of application. It is applied to stretching the dynamic range of an input image. Consider an input image I consists of total number of pixels n and intensity level z . The input probability density function (PDF) can be computed as shown in equation (2).

$$\boldsymbol{PDF(I_z) = \frac{n_z}{n}} \quad \ldots\ldots\ldots (2)$$

where $z = 0, 1, \ldots, z-1$, n_z constitutes the whole summation of pixels value at intensity level l_z and $l_z \in \{l_0, l_1, \ldots, l_{z-1}\}$. The input cumulative density function (CDF) can be acquired by equation (3):

$$\boldsymbol{CDF(I_z) = \sum_{a=0}^{z} PDF(I_a)} \ldots\ldots\ldots (3)$$

The transfer function can be acquired just after the input CDF is obtained and it is shown in equation (4):

$$\boldsymbol{TF = (I_z - I_0)(\ CDF(I_z\ )) + I_0} \ldots\ldots\ldots (4)$$

Wherel_{z-1} is the maximum intensity level and l_0 is the minimum intensity level of an image. Since $CDF(l_{z-1}) = 1$ and $l_0 = 0$, the transfer function of HE can be simplified as equation (5), [16].

$$\boldsymbol{TF = CDF(I_z)} \ldots\ldots\ldots (5)$$

V. PROPOSED METHOD

In this paper the histogram equalization method is proposed for medical image enhancement. At first the medical images are reading from the database that contains MRI brain images that collects from

the web. Then the image is resized followed by colour space conversion, after that median filter is applied to remove any noise in the image. At end the histogram equalization is used to enhance the contrast of the image. The general architecture of the proposed method is shown below in Fig. 2 :

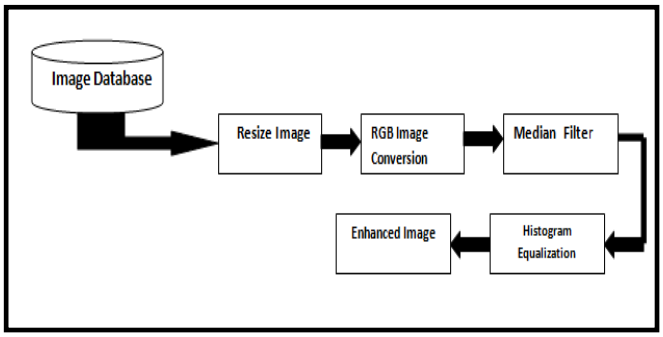

Fig. 2 : Block diagram for medical image enhancement.

A. Image Database

In this work the first point was the creation of a database with MRI brain medical images that collect from the web with different sizes as shown in Fig. 3 :

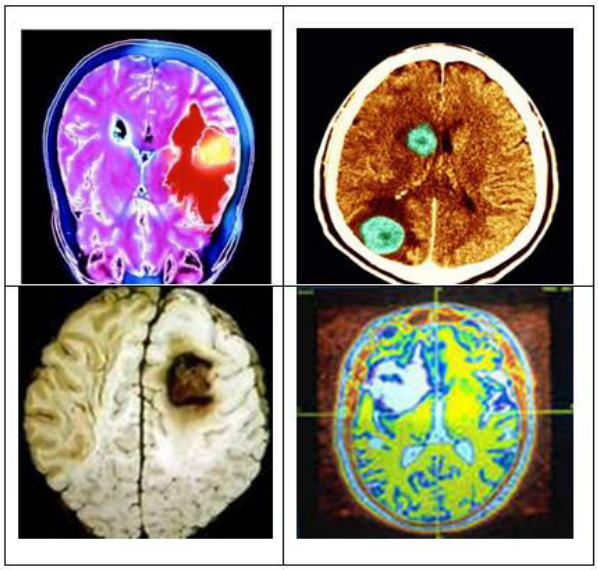

Fig. 3 : MRI brain images.

B. Resized image

The image that reading from the database is resized into the size of (200 x 200) pixels. Image resizing is done in order to reduce the time for processing by the computer and allowing algorithm for better performance.

C. RGB Image Conversion

The collared medical image is converted to gray scale image by converts RGB values to grayscale values by forming a weighted sum of the R, G, and B components using equation(6):

$$y = 0.2989 * R + 0.5870 * G + 0.1140 * B \ldots (6)$$

D. Median filter

The grayscale image may have some noise, for image enhancement these noise must be removed, median filter with (3x3) size is used. The median is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value. (If the neighborhood under consideration contains an even number of pixels, the average of the two middle pixel values is used).

E. Histogram Equalization

The histogram of an image is a plot that displays the distribution of intensities. MATLAB inbuilt function **(imhist)** is used to generate the histogram which outlines the n equally spaced bins, each represents the range of data values and then calculate the no. of pixels within each range.

VI. EXPERIMENTAL RESULTS

The experiments of the proposed HE enhancement method are implemented on Intel Core i7-2330M CPU, 2.20 GHz with 2 GB RAM under Matlab environment and a Windows 8 platform. At first the colour MRI brain image is reading from the database then it resized .The RGB resizing image is converted tograyscale as shown in Fig. 4 :

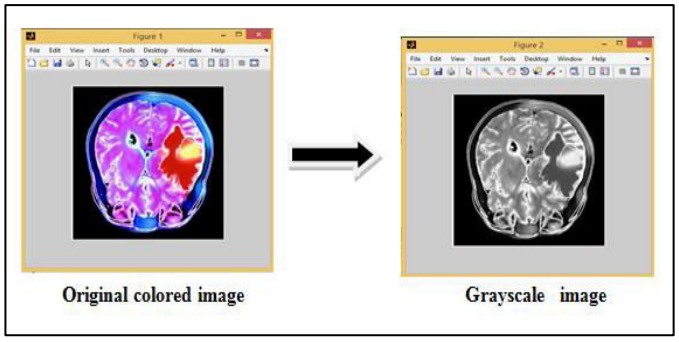

Fig. 4 : Colour Image conversion.

Then the grayscale image is filtered using the median filter as shown in Fig. 5 :

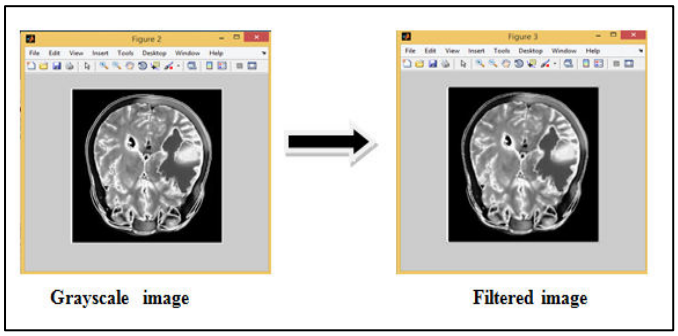

Fig. 5 : Grayscal image after filtering.

After that the HE is applied using the MATLAB inbuilt function (**imhist) to** generate the resultant image, as shown in Fig. 6 :

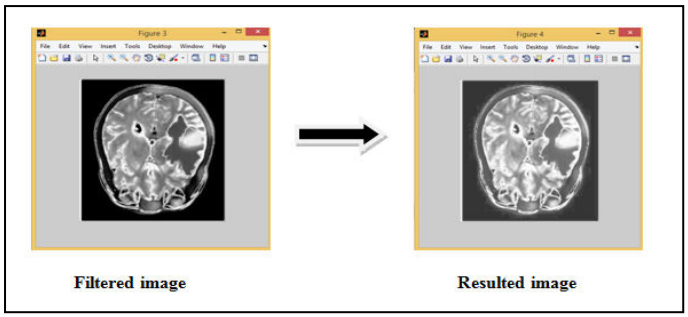

Fig. 6 : The enhancement image.

The histogram for both the original image and the Enhancement image is shown in Fig. 7:

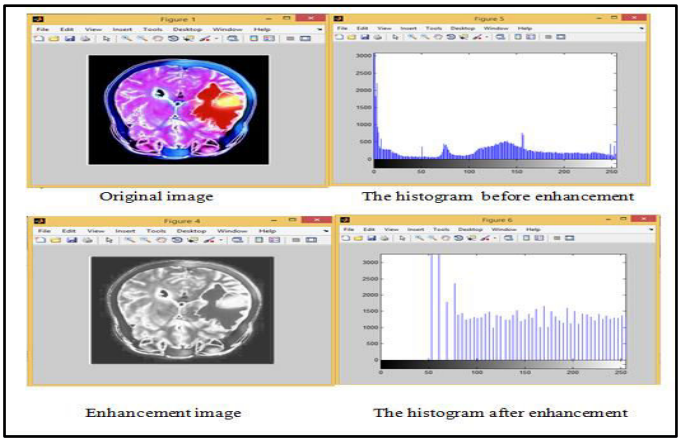

Fig. 7 : The histogram for medical image before and after enhancement.

The same steps applied for the rest images given the result as shown in Fig. 8 :

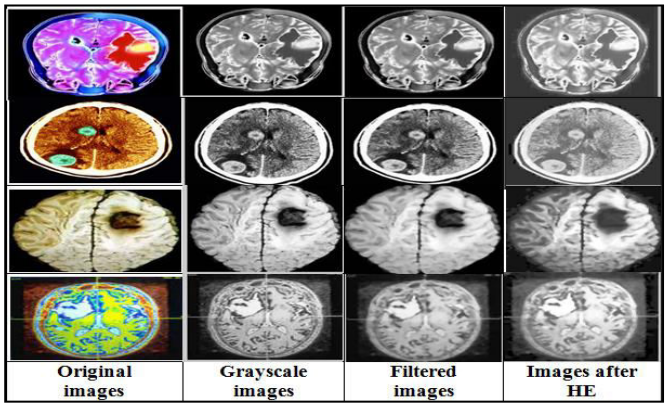

Fig. 8 : The result for medical image enhancement.

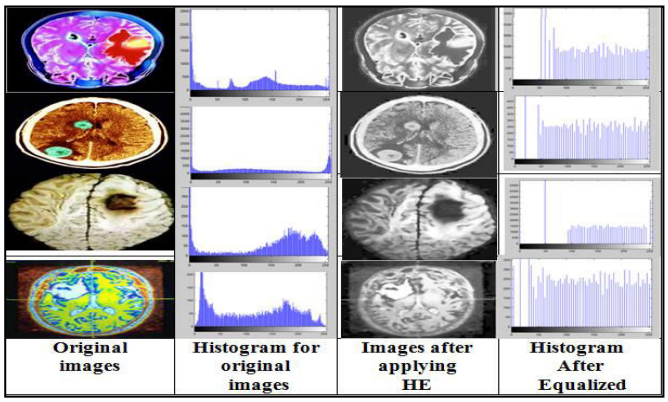

Fig. 9 :The result for histogram of the original images and the histogram of the enhancement images.

VII. CONCLUSION

This paper presents an efficient method for the enhancement of low contrast medical images by using the Histogram Equalization, which is one of the most common, simplest and effective methods for enhancing the contrast of image. Histogram Equalization uniformly distributes the grey level of the original image histogram as a result of which a good contrast enhanced image is obtained. histogram equalization process tries to merge the adjacent gray levels together in order to force the uniformity of number of pixels in each appeared gray levels. Consequently, the intensity saturation will be presented in darkness regions and whiteness region. Histogram equalization assigns the intensity values of pixels in the input image such that the output image contains a uniform distribution of intensities. It improves contrast and obtain a uniform histogram. This technique can be used on a whole image or just on a part

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