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MRI Cancer Medical Images Enhancement Using CLAHE Technique

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Abstract: The Medical images are of great importance in the medical field because this images help doctors to diagnose diseases correctly. Most of the medical images including Computed Temography ,X-ray, and the Magnetic Resonance Imaging all have low contrast, and this greatly affects the accuracy of the diagnosis of the disease, therefore, the process of improving medical images has become a necessity in order to make the details of the medical image visible, which helps in the accurate diagnosis process. In this paper, an effective method has been proposed to increase and improve the clarity of medical images by using a CLAHE technique where this method is effective, fast and with very good results as shown in the results obtained.

Keywords—*Contrast Enhancement ; Medical Image; Image Enhancement;image processing*

I. INTRODUCTION

Medical image processing plays a very important role in medical research as well as the medical field. Recently, medical image analysis has been greatly developed for a large number of medical images by improving the methods used in digital imaging in terms of quality and increasing variety. Conventional techniques used in medical image analysis have limited success rates, but these techniques have not been able to handle the huge amounts of image data. The use of digital computers is the main and important idea in medical image processing[1].Medical Image comprise significant data that clinicians need to analyze and settle on the appropriate treatment choices. The process of diagnosing the disease is very dependent on the visual perception of the medical image. The possibility of an error in perception is unfortunately considered unacceptable because it will seriously affect the life of the patient. A process that using for improving the image is lead to enhance the quality for the image so it will help doctors to make a sound decision that will save the lives of many patients[2].In medical image processing, image enhancement is usually used very extensively, the presence of poor contrast and unwanted noise leads to differences in lighting and other artistic works while obtaining these images such as magnetic resonance imaging as well as computed tomography. The process of improving surgical results is done by integrating techniques of image guidance with surgical procedures the efficiency of image guidance techniques are effected by undesired image artifacts[3].The medical imaging process includes many different processes and methods in order to photograph the internal parts of the human body for the purpose of accurate diagnosis and treatment. However, there are many aberrations in medical images, the most common of which are noise, poor image quality, and the presence of several objects near adjacent pixel values, which makes the diagnosis process difficult and arduous[4].The process of improving medical images is of great importance as it enhance and improves the quality of these medical images in order to diagnose diseases[5]. The organization

for this research is as follows, section 2introduced the works that related with this paper , then section 3 explains medical imaging. The histogram image enhancement discussed in section 4.section 5, presented the proposed method. Section 6 ,show the results that obtained from the experiments. At the end, the conclusions of this work introduced in section 7.

II. RELATED WORK

At the past few years the enhancement of medical images has become an active research subject in the medical field. Many techniques based on different contrast enhancement are proposed.[6] Introduced a new method in order to improve the brain magnetic resonance image. This method is known as the mean intensity substitution the base of this method is the Gray Wolf Optimization Histogram Equalization (GWOHE) equation. FLAIR images is used to applying this method after that the comparison with the current technology for parameters such as AMB and PSNR is tabulated.[7] introduced a new technique to improve the medical image based on histogram adjustment technology. This method is called adaptive extreme level gamma correction canceling including weighting distribution (GCAELEWD). This technique was used in order to raise the difference in intensity on computerized tomography (CT) for the image of brain. It is worth noting that this new approach helps protect the neighborhood change of brightness in the input image at the same time increasing the dynamic range of the input image. [8] proposed an approach that could enhance and improve the quality of the ultrasound images, and this improvement is done by effectively reducing the speckle noise. They covered the sound of the spikes through the use of image filters, after which an ultrasound image was created that was detected on the edge. The techniques that were used, are Fourier filters, medium filters, graph equation, and Sobel filters.[9] Introduced a new method for improving MRI images in which the Enhanced Grass Hopper Optimization Algorithm (EGOA) was used to improve BF parameters. Rician noise and impulses are added to simulate magnetic resonance images (with different contrasts). In the regions where window size, spatial range and intensity are searched, EGOA was used in order to apply it for the images that have noises in these regions for the purpose of obtaining the optimal filter parameters. PSNR is a more suitable value for optimization.[10] presented an enhancement technique using neural based fuzzy. Wiener filter is used for the pre-processing of the images. then the (LTH) local transform histogram is used to obtain the contrast enhancement ,after that the neural based fuzzy enhancement is take the enhanced image which performs the procedure in three steps first fuzzification , second membership function and third defuzzification.

III. MEDICAL IMAGING

Medical images have a huge and very important role in the process of treating patients. As the medical image depicts different tissues and parts in the human body, in order to diagnose diseases and treat patients accurately by doctors, the process of improving the medical images has become very necessary[11].The most advanced field in the field of imaging is medical imaging. In medical imaging, a visual representation of the internal parts of the human body is required for the purpose of diagnosing diseases or in the event of abnormalities. In the field of medicine, there are many recent developments in image types, like X-ray , ultrasound ,computed tomography, magnetic resonance imaging MRI, and PET scans.[12].Medical images in tissues are usually of different quality contrast. In some applications, there are few medical images that are of sufficient quality for the purpose of treatment. For example, in conventional CT images, the contrast is high between the bone and the background, and X-rays of the bones provide a higher resolution than conventional radiography. But the available contrast is low in most cases.[13]There are advanced imaging camera systems as well as optical technologies through which medical images are taken and collected. Examples are MRI, CT scan, and X-ray. The medical images taken suffer from poor contrast and noise. That's why contrast-enhancing techniques are used to work on the quality of medical images, as well as their processing in low light conditions[14].

IV. HISTOGRAM IMAGE ENHANCEMENT

In many vision applications, the improving of the image plays an important and essential role in this applications. As the increase in image quality is improved through image enhancement technology so that it can be seen by both men and machine easily[15].The techniques used in image enhancement include frequency domain and spatial domain methods. The methods of spatial domain work on the value of the pixel this will

introduce better optimization. Spatial field optimization methods include universal law of power transformation, adaptive law of power transformation, spatial, filtering as well as methods for point-processing, log transformation, gray-level transformation, histogram processing, image negatives, image operators, and partial linear transformation. As for the frequency domain method, it involves working on the common elements mainly for image transformation as in the Fourier transform , discrete cosine transform, and discrete wave transform.[15]. There are certain techniques in performing image enhancement that are useful in improving the visible part of the image in order to make it suitable for both analysis as well as processing. Image contrast processing is one of the processes applied for image enhancement.[16].One of the common tools used in medical image enhancement is histograms. Loss of contrast is restored by redistribution of image brightness values, which can often produce incorrect and undesirable results [2].

A. Histogram Equalization

The histogram equalization, considered as one of the universal techniques for improving the contrast in the image as it is widely used for both color images as well as grayscale images. Histogram equalization (HE) is a useful method for obtaining a unique input in the output variance transfer process[17]. The method of graph equation (HE) is one of the most important methods used in the process of improving images and one of the most prevalent methods, and the reason for this is that it is an effective method as well as simple and one of the most important areas in which it is used is the improvement of medical images. Because it is a simple and efficient method, it has become very popular in improving the contrast of images. For example, the method of processing sonar images and preparing the radar image. The HE technology is represented in the possibility of resetting to the dark levels of the image based on the image gray levels (CDF)) and the cumulative density function. The strong range of the resulting image histogram is normalization and stretching by HE and as a result, it upgrades the image differentiation and gives a total diffraction improvement [18]. The Histogram Equalization (HE) technology is a global technique used to improve contrast and in a very wide range of color images as well as grayscale images together. In this method (graph equation (HE)) an appropriate input to the output variance transfer process is obtained. histogram equalization publishes and normalizes the graph of the number, of pixels in the image at each gray- level value.[17]. The histogram equalization's idea is to find the intensity transform in order for the histogram for the transformed image to become uniform. Suppose for an image f(x,y) , that h(i) is its histogram and the accumulative function of h(i) as:

$$c(i) = \int_0^i h(t)dt \qquad (1)$$

Such a transformation we can prove that it makes the variable y= (ci) follow a distribution in a uniform style, therefore, for the image that has 256 gray levels we can perform the histogram equalization process through the following equation.:

$$f = \frac{256}{m} * c\big(f(x,y)\big) \qquad (2)$$

Where : m is indicate the whole number of pixels in the image[19].

B. Adaptive Histogram Equalization (AHE)

AHE is a different method used to enhance the image's contrast . Its idea is completely different from the usual HE. in AHE technique, many of histograms are calculated and each one of these histograms fits with distinct squares of the image rather than the whole image and this is used to redistribute the image intensity. In AHE, a transformation process that is derived from an adjacent region is used to transform each pixel. Every pixel is simply transformed according to the histogram of the square that surrounds each pixel. Regardless of this, AHE works to increase and strengthen noise in somewhat homogeneous areas in the image[20].So for this reason AHE is very useful for enhancing the local contrast of each image's part . In this method, AHE transforms each pixel according to the histogram of the box that surround the pixel. The function used for transformation is equivalent to and perfectly from the normal HE. As for the AHE technique, it is completely dependent on the adjacent pixel values[21].

C. CLAHE (Contrast-Limited Adaptive Histogram Equalization)

One types of AHE is Contrast-Limited Adaptive Histogram Equalization (CLAHE). It divides the original image into a set of sub-images without overlapping. After that, the histogram of the sub-images is cropped in order to reduce the quantity of enhancement for each pixel, and after that it is equalized, the information of the image are obviously visible, also, simultaneously, the image's background is equally enhanced with the foreground, that will results in a high contrast output image [22].There is a difference in the CLAHE as of the normal AHE in terms of the contrast limit, these feature or characteristic can be applied to a general HE, and this will lead to a contrast limited histogram equalization(CLHE).In practice, this technique is rarely used. In the CLAHE technique, the procedure for determining the variance must be applied to each region since the function of transformation is derived from it. This technology has been developed for the important purpose of preventing the excessively large noise amplification that results from AHE[23].

V. PROPOSED METHOD

There are several stages that the proposed method consists of. In the first stage, the medical image is read from the database, which in turn contains a set of medical images of the MRI brain , which were taken from the Web. In the second stage, the image size is changed to a smaller size to help speed up the procedure, the third stage includes color space conversion, and in the last stage the CLAHE algorithm is applied. The general structure of the CLAHE method proposed below is shown in Fig.1 :

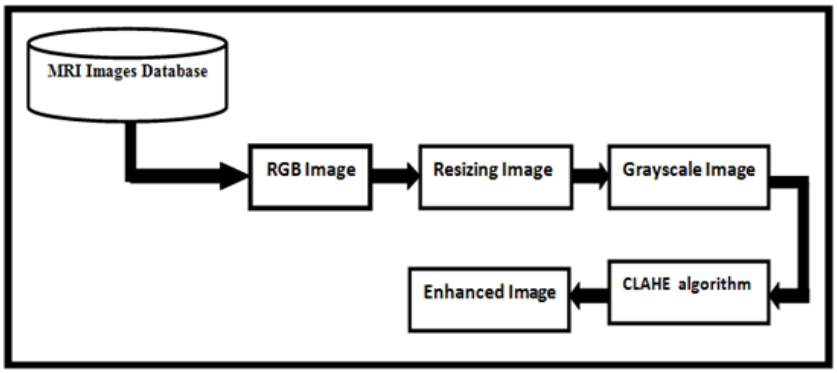

Fig. 1: General structure of the proposed method.

A. Image Database

For this work, MRI images were used in order to perform the image enhancement process. The database consists of six color images collected from the web. Images of different sizes Fig.2 show database images:

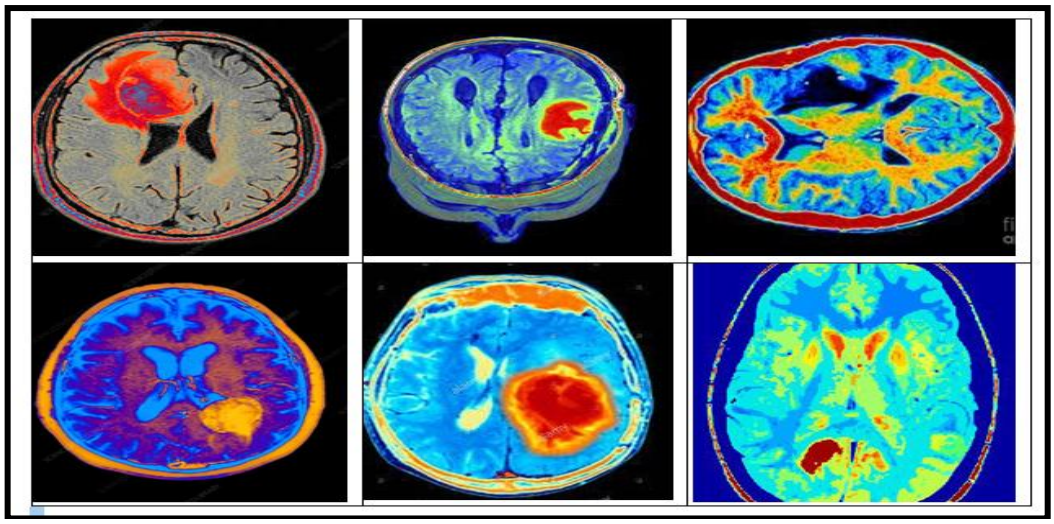

Fig. 2: Database Images

B. Image Resizing

After the process of reading the medical image from the database, the entered image will be resized to a size of (200 x 200) pixels. This procedure will help reduce the time required for processing by the computer as well as allow better performance of the algorithm.

C. Color Space Conversion

The reduced image will be converted from a color image to a gray scale image. This will result in the colors being removed and keeping only the luminance for each pixel. This is done by using equation.3. The result will be a grayscale image that has a gray scale intensity ranging from 0 to 255.

$$y = 0.2986R + 0.5870G + 0.1140B \quad (3)$$

D. CLAHE Algorithm

Input : MRI medical image ,Output: Enhanced Image

1- Read the medical image

2-Combine a histogram for the input image

3- Apply the Contrast-Limited Adaptive Histogram Equalization algorithm

4-Produce the enhanced image

VI. EXPERIMENTAL RESULTS

The experiments, of the proposed enhancement method that based on CLAHE algorithm are implemented using the Matlab environment and a platform of Windows 8 . At the beginning, from the database of the colored medical images an image is read , the database containing a collection of medical images, then the image is resized .After that the resized color image is transformed to grayscale image ,as shown in Fig. 3:

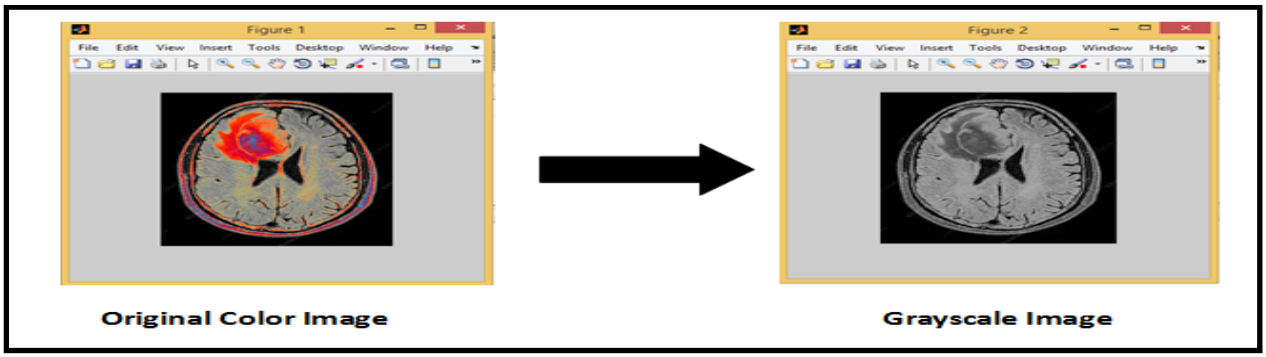

Fig. 3: Transformation of RGB image to grayscale .

After that the algorithm of CLAHE is applied to the grays-cale image in order to produce the enhancement image this process show in Fig. 4:

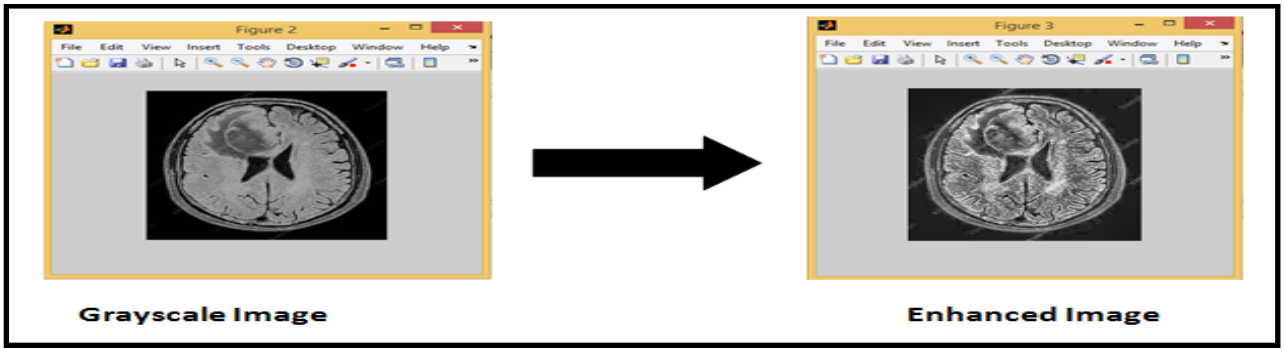

Fig. 4: The enhancement image.

For both images (original and the enhancement) the histogram is plot using the Matlab function (hist) , the result for applying this function is shown in the Fig.5 :

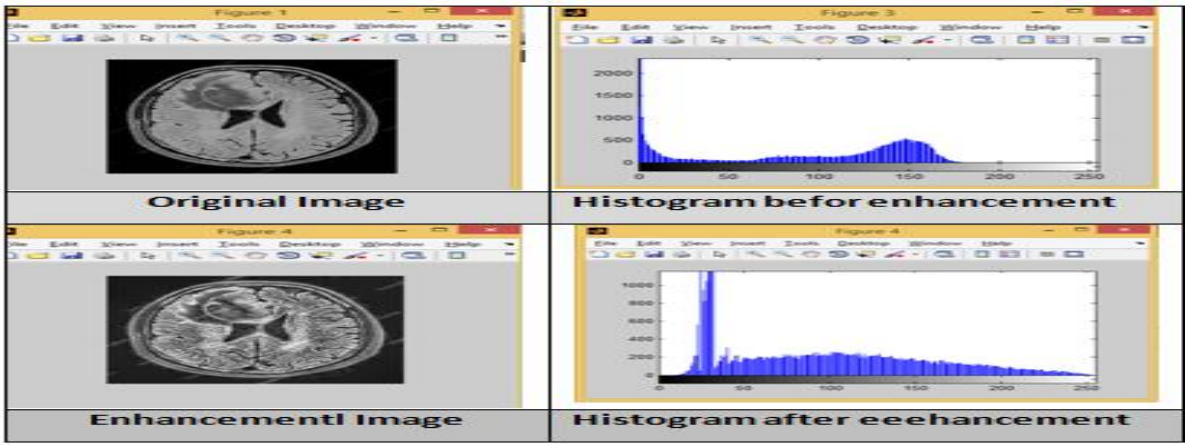

Fig. 5: The histogram for the original and the enhancement images

For the rest of the images in the database, the same previous steps will be applied, and therefore the results will be obtained this is shown in the Fig. 6 and Fig. 7 respectively :

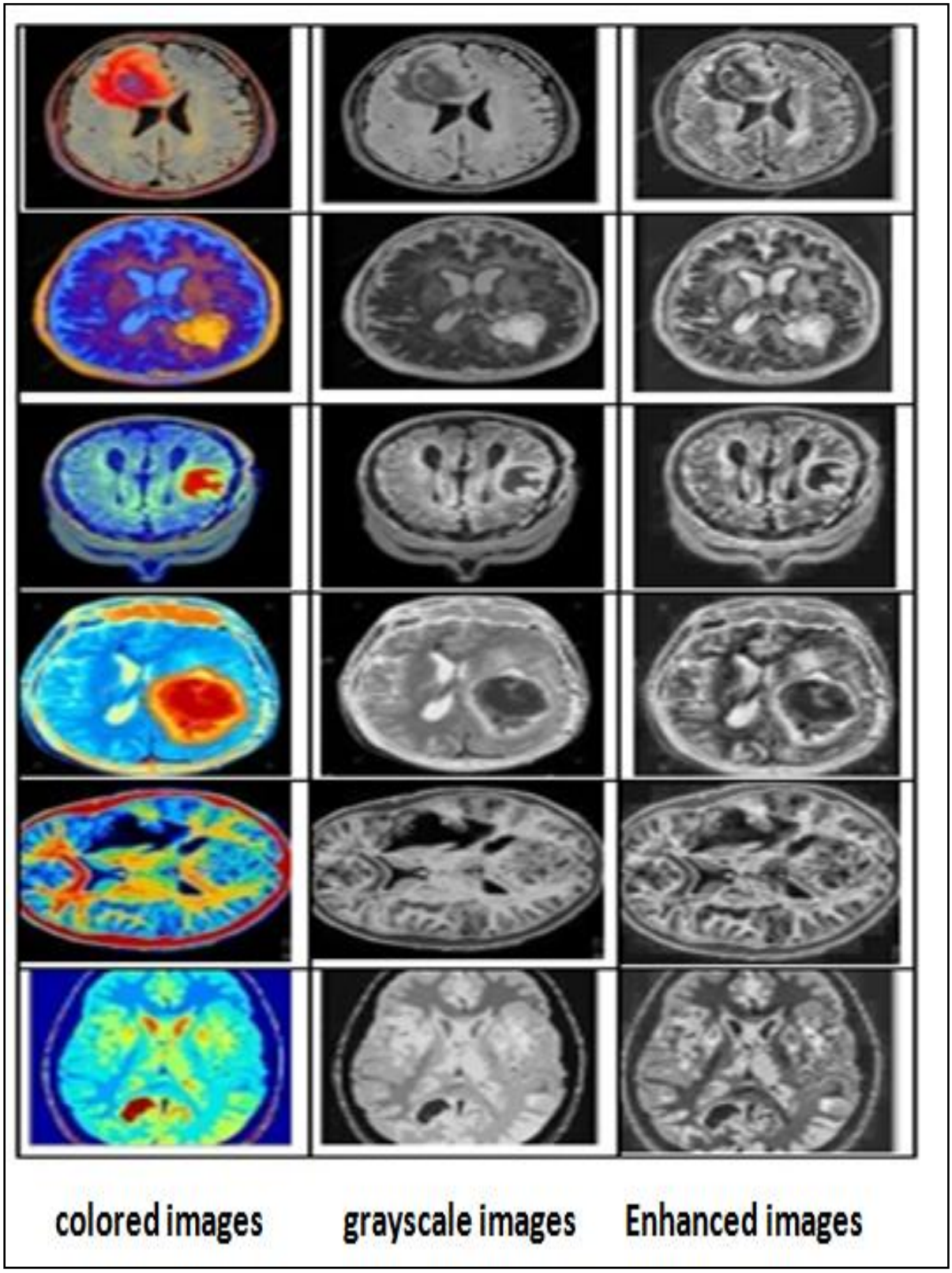

Fig. 6: The enhancement images.

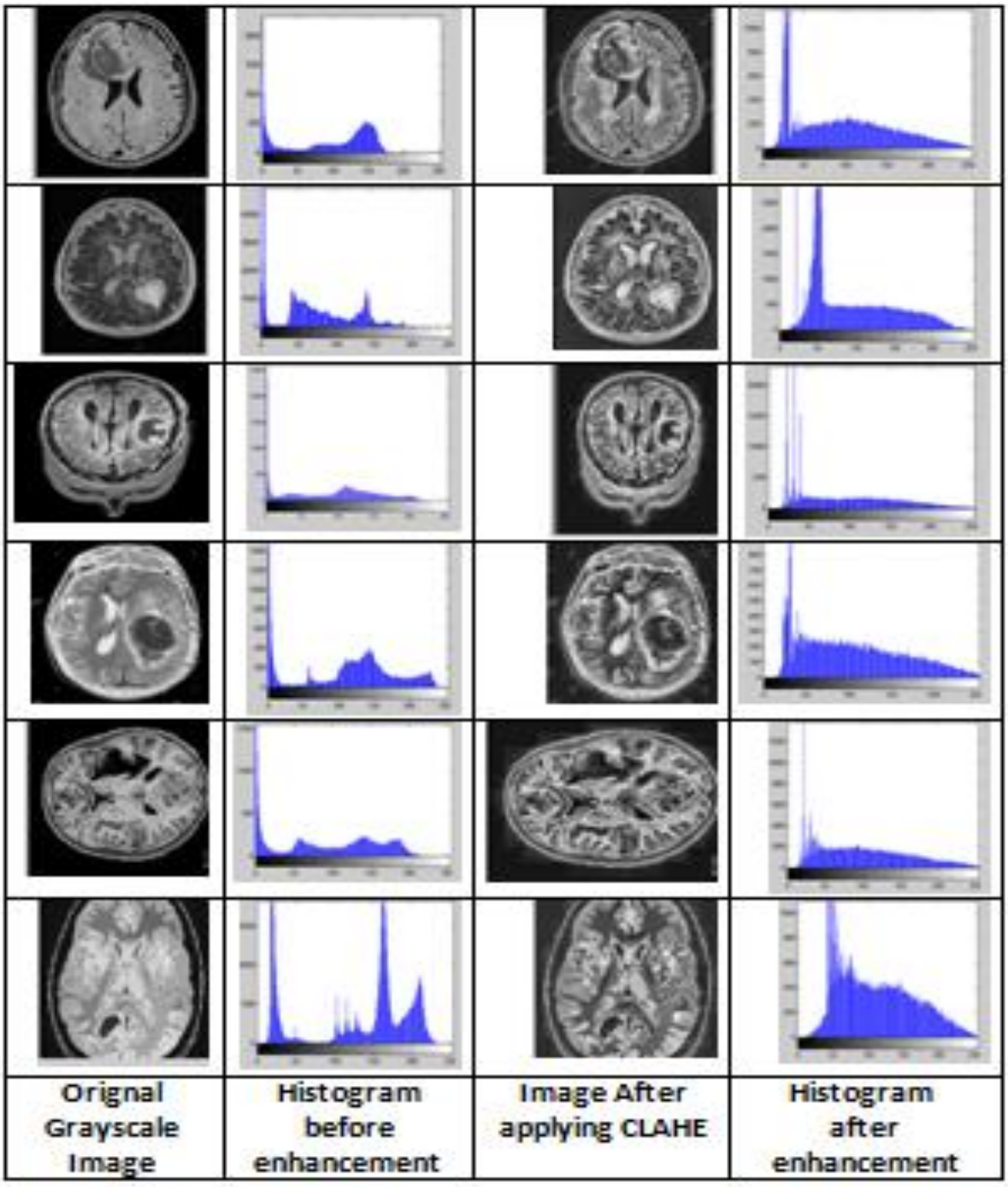

Fig. 7: The result for the histogram of the images before and after enhancement

VII. CONCLUSION

This paper presents one of the most important and effective method used to improve the low contrast of medical images through the use of a CLAHE technique which is more widely used and also characterized by being simple and with very good results. CLAHE is a technique used to enhance the local contrast of images. CLAHE is a mix of the histogram equalization (HE) and the Adaptive Histogram Equalization (AHE), here the histogram is equalized in blocks with a predefined segment bound in an adaptive manner. For CLAHE technique, it does not work on the whole image, but on small areas of images, these areas are known as squares.

It works on each tile like a normal Histogram Equalization (HE) .The obtained results show the effectiveness of this method in enhancing the medical images.

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