To Study on Image Enhancement Based on Histogram Technique for Medical Images

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Abstract: *Image enhancement (IE) is the process of enhancing visual appearance of image in order to make it more effective for computer to process. The look and visibility of image rely on human eyes, which vary from one person to another. Several enhancement methods are used to improve the clarity of image, but different application require different types of techniques for enhancing image quality. In this review paper, we present different enhancement techniques categorized into spatial and frequency domain to classify image quality with its advantage and disadvantage. 1. This paper proposed an effective algorithm called "TGC" to enhance the medical image which gives better result. Comparatively the experiment result provides good accuracy range value. 2. This paper proposed algebra algorithm called "MAM" to enhance the medical image which gives better result. Comparatively the experiment result provides good excellent accuracy range value.*

Keywords: Image Enhancement, Spatial Domain, Frequency Domain, Histogram Equalization, Time gain control.

1. Introduction

Digital Image Processing

An image could also be outlined as a two-dimensional perform, wherever x and y area unit spatial (plane) coordinates, and also the amplitude of f at any combination of coordinates (x, y) is named the intensity or grey level of the image at that point. When x, y, and also the intensity values of *f* area unit all finite, distinct quantities, thus tendency of this decision is the image called as digital image. The field of digital image processing refers to process digital pictures by means of a computer. Note that a digital image consists of finite variety of parts, an explicit location and price. These parts area unit referred to as picture elements, image elements, and pixels. This pixels component is that most generally denoted as the element of a digital image.

Fundamentals of Digital Image Processing

Image fundamentals:
It is a simple image formation model, sampling and quantization, connectivity an adjacency relationships between pixels. The stage of fundamentals in digital image processing is described.

Image Enhancement:
Spatial domain filtering: Basic intensity transformations are negative, log, power-law and piecewise linear transformations, bit-plane slicing, histogram equalization and matching, smoothing and sharpening filtering in spatial domain, unsharp masking and high-boost filtering.

Frequency domain filtering:
The transformation are Fourier series and Fourier transform, discrete and fast transform, sampling theorem, aliasing, filtering in frequency domain, low pass and high pass, and band pass filter, notch filters.

Image Restoration:
Image restoration can be applied on image in presence of noise in an image, periodic noise reduction, linear and position invariant degradation, estimation of degradation function, can be done to remove noise and unwanted distortion present in an image.

Image Reconstruction:
Image Reconstruction describes the principles of computed tomography, projections and Radon transform, the Fourier slice theorem, reconstruction using parallel-beam and fan-beam by filtered back projection methods.

Morphological Processing:
The techniques used are erosion and dilation, opening and closing, the Hit-or-Miss transformation, various morphological algorithms for binary images.

Wavelet and multi-resolution Processing:
These techniques are Image pyramids, sub-band coding, multi-resolution expansions, viz the Haar transform, wavelet transform in one and two dimensions and discrete wavelet transform.

Object Recognition:
The object recognition is more essential technique today. The feature matching and pattern recognition is used for security process and also in our proposed method for image enhancement which is more useful.

Segmentation:
Segmentation procedures partition an image into its constituent parts or objects. The focus of the segmentation is to achieve the division of region of interest part.

Representation and Description:
Representations follow the output of segmentation and denoted with raw pixel data by either the boundary of region or for entire region. Description is called feature selection, deals with extracting on class of objects from another.

Applications of Digital Image Processing

Some of the major application that associated with the digital image processing is listed below,

○ Document Handling
○ Signature Verification
○ Biometric Identification
○ Target Recognition

- o Arial Photography
- o Autonomous Vehicle
- o Video Processing
- o Human Activity Recognition
- o Medical Application
- o Machine / Robust Vision

Image processing is a very active area of research in computing environment. In day to day life cycle, several applications include medicine to transportation and industry as well. A necessary requirement of digital image processing that creates enhanced contrast with hiding information in areas like biomedical image analysis, fault detection and remote sensing. So, the methods that process a given image into visually better resultant from original one are called Image Enhancement (IE).

(a)Original Image   (b)Enhanced image
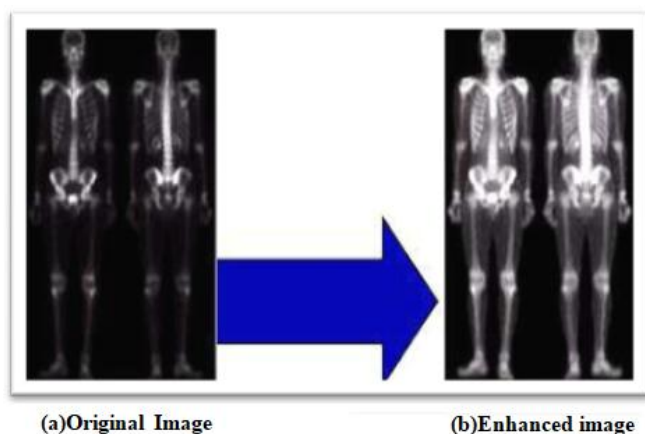
IE method is the process of improving the visual quality of digital image, without the prior knowledge of source degradation. It is the method of improving the images perception of information in human views.

The principle work of IE is to build differentiate in a low complexity picture or to discover the concealed points of interest in a picture. At whatever point changing over a picture for digitizing reason some type of debasement happens at the yield.

The principal method behind enhancement is to find cover or hidden details inside image. Enhancement is you to re-establish or kept a picture that has some type of disintegration the optics, hardware as well as condition or to upgrade certain elements of a picture. Examples of image enhancement (IE)method is medical images detection in which need of quality or clarity of images for human viewing purpose, for which removing noise, increasing contrast, and revealing details. Here image enhancement is important to enhance contrast and reduce noise, so quality of image increases.

The rest of the paper is organized as follows, the introduction of image enhancement and methods, image enhancement literature survey paper, image enhancement techniques and its filter in domain, the advantage/ disadvantage of enhancement, the application of enhancement in various domains, the histogram equalization methodology and its types to enhance the image quality, the performance measures and the research work with future work.

2. Literature Review

Rajesh G, Bhawna M, Sheetal G, (2011) explained Histogram Modified Contrast Limited Adaptive Histogram Equalization (HM CLAHE) to regulate the level of contrast enhancement, that result is a strong contrast image that brings the location details more relevant to interpretation. In this modified histogram is used as both optimization method and CLAHE. Enhancement Measure (EM) is evaluated using E. Their result of proposed is better contrast enhancement with preserving the neighborhood information on the Enhancement images.

X. Fang, J. Liu, W.G and Y. Tang, (2012) to enhance the image fusion result with assessment on sharpness. As we know that Image enhancement (IE) improves the perception of information. In this algorithm at first an image is taken from a real scene and then it is separated into many regions according to the use for enhancement.

S.S.Chong, (2013) Modified Histogram Based Contrast Enhancement using Homomorphism Filtering" on medical images. In all types of medical images, histogram based

Techniques enhance the low contrast for proper visual. This method work in two parts, in first part enhanced the image global contrast and second part image is sharpening using homomorphism filtering. And this filtering is followed by image normalization. The proposed algorithm result proved as efficient and flexible for medical image enhancement and can be closed a pre-processing step for proper analysis and understanding of medical image.

Agarwal, T.K, (2014) an improved forms of hyperbolic algorithm contrast enhancement technique suitable for magnetic resonance imaging (MRI). In this method contrast enhancement of image is done by controlled fusion of the gray level stretching on structure. The experimental result of proposed method is better on contrast and also avoids the over enhancement of image by maintaining the overall image brightness.

Shikha M, Richa D, (2015) Enhancement of image algorithm is based on the weighted filter, histogram equalization (HE) and wavelet transformation to solve this problem. The experimental results shows that proposed approach can enhance the high-contrast images effectively, it is not only improves the global brightness and contrast of images but also preserves details and remove noise. The other advantage of the proposed method is that it is fully automatic and requires no parameter settings. Therefore, it is useful and suitable for most digital camera users.

Zhijun Y, Zhongyuan L, Chun W, (2016) Enhancement is controlled by use of histogram modification method and maximizes entropy in the HE process. Subjective evaluation result was better over other methods according to natural appearance.

Mehadi J and Shohresh K (2017) they proposed a work "Automatic Brain Tissue Detection in MRI Images using seeded Region Growing segmentation. The study states that paper presents a medical image based method for automatic classification of magnetic resonance images (MRI) of brain

Paper ID: ART20191909   DOI: 10.21275/ART20191909   642

under three categories of normal, lesion benign, and malignant. The technique consists of six subsequent stages; namely, pre-processing, seeded region growing segmentation, connected component label (CCL), feature extraction, feature Dimension Reduction, and classification.

Sangeet S, (2018) they proposed a work "Image processing and cryptography". The study focus on Improvement of pictorial information for betterment of human perception several fields such as satellite imaging, medical imaging etc are renewed research thrust. Specifically we would like to elaborate our experience on the significance of computer vision as one of the domains where hardware implemented algorithms performs far better than those implemented through software.

3. Methodology

Techniques of Image Enhancement
Relevant Image enhancement (RIE) is used to enhance the visual appearance of image, so that human eyes can easily view or understand image, input for other image processing techniques. These techniques are defined into two domains.

Spatial Domain
This technique directly deals with the image pixels and the values of pixels are changed to get desired enhancement. The main use of this technique is that they are easy to understand and complexity is low that favor real time implementations. Spatial Domain includes techniques.

Log Transformation Technique
In this transformation technique the basic image enhancement of spatial domain can be efficiently used for contrast enhancements of dark images. The log transform is basically a gray level transform and the pixels are changed to gray level. This transform technique determines the values of low gray level of input image to a wider range of output levels. The general equation of transform is given as S=c log (1+r) where S is output grey level, c is a constant and r is the input grey level. It is assumed that $r \geq 0$.

Powers-Law Transformations
In this transformation, image transform is guided by equation known as Gamma correction and the value of gamma Y decides the level of enhancement.

In this domain, an image is first transformed into frequency domain. All the enhancement operations of image are executed on Fourier transform then the reverse process of inverse Fourier transforms are executed to get the resultant image. The result of output image pixel values are changed on the basis of applied transformation function. The techniques includes in Frequency domain are DFT, DCT, low-pass filter, high-pass filter.

1) Low pass filter:
In Low pass filtering includes the removal of high frequency components from an image that result is sharp transitions reduction that are associated with noise. In case of idle low pass filter keeps all the low frequency components and removes all high frequency components that results two issues in low pass filters. Basically such problems are affected by the shapes related with the spatial domain filters.

2) High pass filter:
High pass filters are mainly used in image to sharper the image view. It works in same way as low pass filters except uses different convolution kernel and focuses on the fine details of image. This filter improves the sharpening of image, while the excessive use of filter results is degraded image quality.

Image Transformation:
Image transformations typically involve the manipulation of multiple bands of data, whether from a single multispectral image or from two or more images of the same area acquired at different times (i.e. multi temporal image data). Either way, image transformations generate new images from two or more sources which highlight particular features or properties of interest, better than the original input images.

Image transformation can be done by logarithmic transformation
The log transformation can be used to make highly skewed distributions less skewed. This can be valuable both for making patterns in the data more interpretable and for helping to meet the assumptions of inferential statistics, a log transformation can make patterns more visible. Both graphs plot the brain Weight of animals as a function of their body weight. The raw weights are shown in the upper panel; the log-transformed weights are plotted in the lower panel.

Therefore, if the arithmetic means of two sets of log-transformed data are equal, then the geometric means are equal. Log transformation in general in shown by this equation

$$s = c\log\,(1+r \qquad (1)$$

It is used to expand the values of dark pixels in an image while compressing the higher values. It compresses the dynamic range of images with large variations in pixel value. It can have intensity range from 0 to 10^6 or higher. We cannot see the significant degree of detail as it will be lost in the display. Example of image with dynamic range: Fourier spectrum Image. As discussed above applying log transformation to an image will expand its low valued pixels to a higher level and has little effect on higher valued pixels so in other words it enhances image in such a way that it highlights minor details of an image as shown in figure below. Fig.1. as has minor details which are not much prominent but after applying log transformation we are able to see those little details.
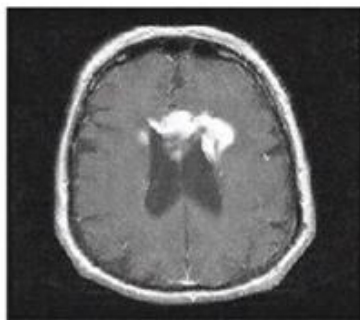
Lightness order smoothing Image

The simulation studies involve the naturalness preservation via lightness order smoothing, which enhance the details and preserved the naturalness. The size of original image has reduced while scaling factor increases and entropy also decreases while intensity increases when scaling factor increases.

The dimension reduced but maintains constant. The decomposition of images via wavelet decomposition for different levels size, dimension and entropy of all are same but increasing the levels Intensity decrease and then increasing. By transformation image by increasing the

scaling factors size and dimension increased and then remain constant. Normalized cross correlation is increased whereas entropy reduces. Intensity, Normalized absolute error, and Mean square error increased and then decreased then remain constant by increasing the scaling factor.
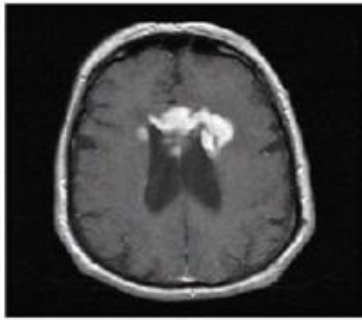
(a) Original Image
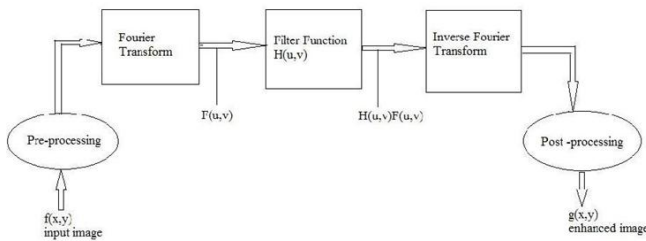

(b) Lightness Order Smoothing Image

Figure 1: Frequency Transformation Diagram

Application of Image Enhancement

Several application areas in which image enhancement is used

1) E-learning: The use of image enhancement in the area of e-learning, where enhances the text written on chalkboard are viewed or present as streamed video to increase the level of text readability.
2) Medical: The application of image enhancement (IE) in medical is to improve the noise and sharpen the image details for visual representation. This makes important tool for reviewing anatomic areas in MRI, ultrasound and x-rays to name a few.
3) Forensic: The use of image enhancement (IE) in forensic is to collect the evidence, identifying and surveillance. The collect images can be used for security videos analysis, fingerprint detection and investigation of crime scene are enhanced so that identification of the protection of victims.
4) Other areas: Several areas of image enhancement (IE) are

Medical imaging, Satellite imaging, Aerial imaging, remote sensing and Digital camera application, Astrophotography, Fingerprint matching.
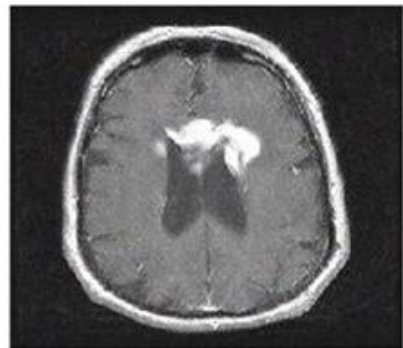
Histogram Equalization Techniques

Histogram Equalization
Histogram is generally a graphic representation of the distribution of data. The histogram defines how certain times a specific gray level (intensity) appears in an image. Histogram equalization technique is used for enhancing the contrast and adjustment in image processing. The technique of histogram can be used in many application areas such as object tracking, speech recognition, and medical image processing such as providing better view of bone structure in x-ray images, improving the foreground and background of photographs in terms of both brightness and darkness.
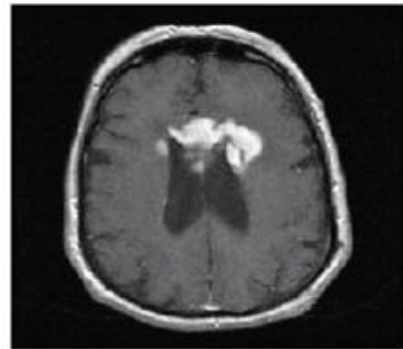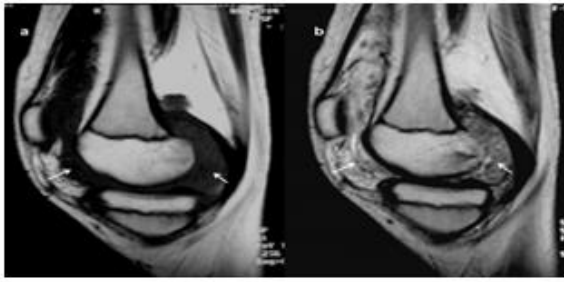

a) Input Image

(b) Output Image

Adaptive Histogram Equalization

Brightness Preserving BI- Histogram Equalization
This technique separates image histogram into two parts. The intensity of partition is defined by the mean brightness value of input that is average intensity of each pixel that forms an input image. BBHE levels the sub-pictures autonomously on the premise of suitable histograms within the imperative, such samples in the correct set are mapped into the range from the base gray-level to the info mean and the examples in the last set are mapped into the range from the mean of the most extreme gray-level. Subsequently, the resultant balanced sub-pictures are encompassed by each other around the info mean, which has a result of saving mean brightness.

(a) Input Image   (b) Output Image

Performance Measurement

Peak Signal to Noise Ratio (PSNR)

PSNR is the evaluation standard of the reassembled image quality and is the most wanted feature. It can be calculate in decibels (dB) and it is given by

$$PSNR = 10.\log_{10}\left(\frac{255^2}{MSE}\right)$$

… (2)

Where the value 255 is the maximum possible value that can be attained in the image signal, higher value of PSNR shows the better reassembled image.

Entropy (En)

Entropy is an index to evaluate the information quantity contained in an image. The higher value of entropy after fusing indicates that performance of fusion improved and increases information.

Mean Square Error (MSE):

It is defined as the average square difference between reference signals to distorted signal. It can be evaluate by adding up the squared difference pixel-by-pixel and dividing by the total pixel count. Suppose m x n is a noise free monochrome image X, and Y is defined as the noisy approximation. Then the mean square error between these two signals is defined,

Signal-To-Noise Ratio (SNR)

$$MSE = \frac{\sum_{i=1}^{M} \sum_{j=1}^{N} [X(i,j) - Y(i,J)]^2}{M * N}$$

… (3)

It is defined as the ratio between signal power to noise power and evaluate in terms of decibels. . Higher the SNR value betters the reconstructed image. Consider r(x, y) be the original image and t(x, y) is enhanced image. The noise estimation in enhanced image is analyzed by,

$$SNR = 10.\log_{10}\left[\frac{\sum_{0}^{n_x-1} \sum_{0}^{n_y-1} r[(x,y)]^2}{\frac{1}{n_x n_y} \sum_{0}^{n_x-1} \sum_{0}^{n_y-1} r[(x,y) - t(x,y)]^2}\right]$$

… (4)

Proposed algorithm
Algorithm 1: Method one
Step1: Start the process
Step2: Take random input from database.
Step3: Apply TGC to get the bright image.
Step4: The TGC is applied over selected image enhancing the brightness of image with range value.
Step5: End of the process

TGC (Time Gain Control)
Emulates real functions such as gain, time gain control (TGC) simultaneously such as gain control, freeze, zoom. Then the mean control error between these signals is defined.
Formula based TGC define by,

TGC = Max (count / double) T… (5)
TGC(x, y) = TGC function (Count)… (6)

Experiment Result

Figure 1:

Figure 2:

Paper ID: ART20191909   DOI: 10.21275/ART20191909   645
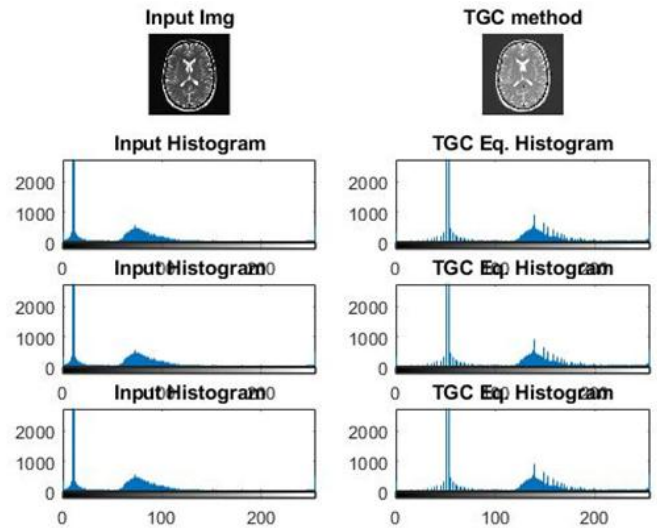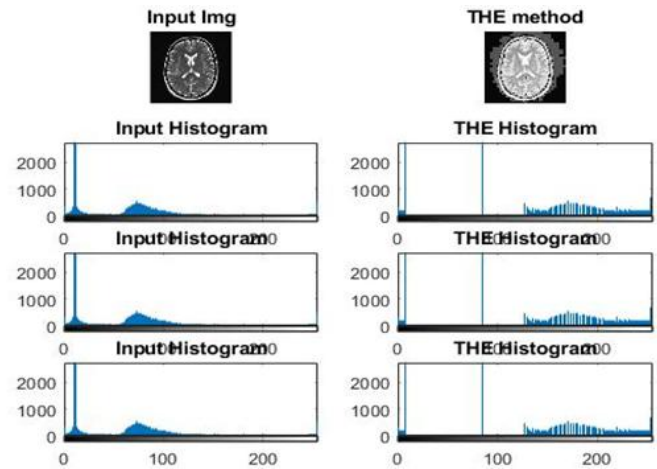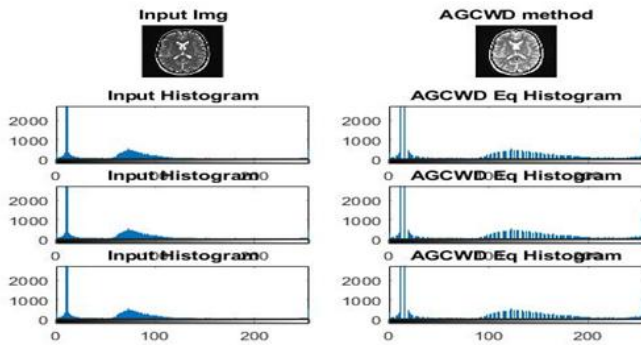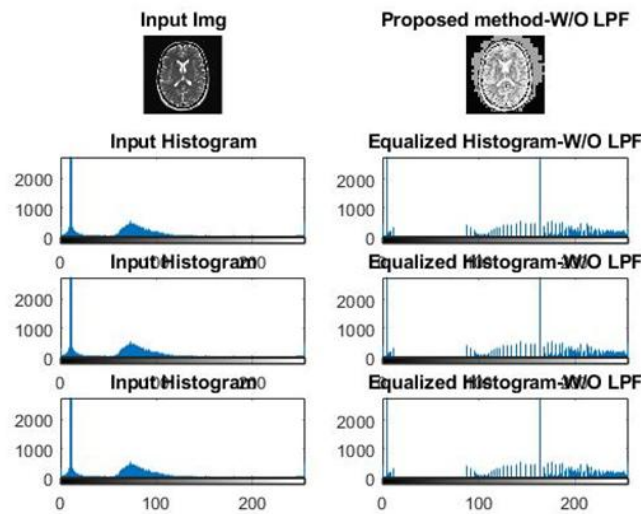
Figure 3:
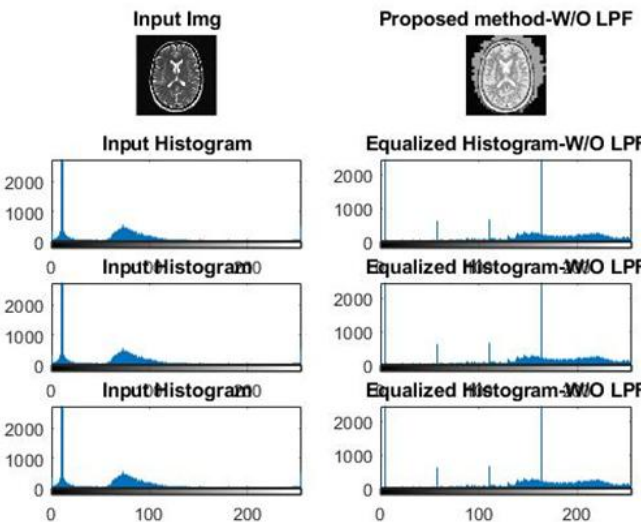

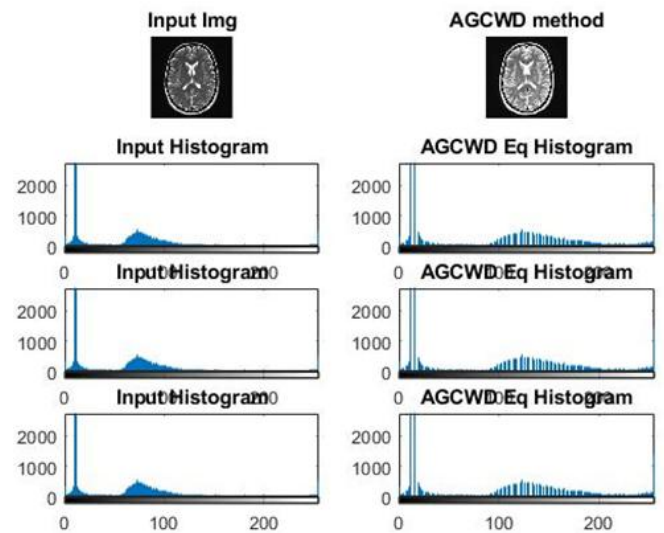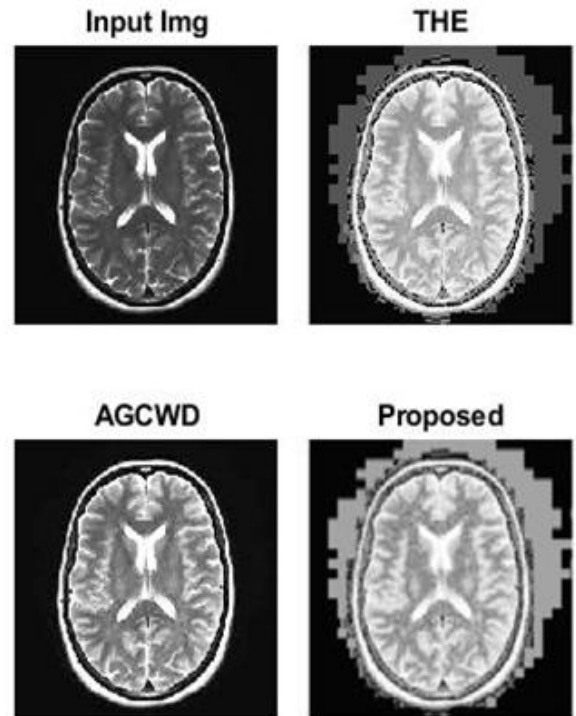**Figure 4:**

Figure 5:

Figure 6:

Figure 7:

Algorithm 2: Method two

The Mathematical algebra Method:

Step1: Start the process
Step2: Take Mathematical algebra function from database
Step3: Apply MAM to get the bright image, also before algorithm apply yet brightness
Of Image with gray color value.
Step4: MAM applied the bright and contrast image value, we get

$$F(x, y) \{ (X^2 - Y^2) = (X + Y) * (X - Y) \}, 0 < n$$
$$\sum F(x, y) \{ \sum (X^2 - Y^2) = \sum (X + Y) * \sum (X - Y) \}, 0 \leq n \leq 1$$

Step4: The MAM is applied over selected image enhancing the brightness of image
From Particular IMG color to Gray color image.
Step5: End of the process.

Mathematical Algebra Method (Proposed Mathod):

$(a2 - b^{2)} = (a + b) * (a – b)$

$\sum (a^2 – b^{2)} = \sum (a + b) * \sum (a – b)$

The sub image X_L is composed of $\{A_0, A_1, A_m, \}$ (1) and the other sub image,

Au is composed of $\{A_{m+1} …. A_{L-1}\}$. The respective cumulative density functions for

$\{A\}_L$ and $\{A\}_u$ are then defined as,

$\sum (a^2 – b^{2)} = \sum (a + b) * \sum (a – b)$

$F\{A\}_L = \sum (a^2 – b^{2)} \{A\}_L$

$F\{A\}_U = \sum (a + b) * \sum (a – b) \{A\}_U$

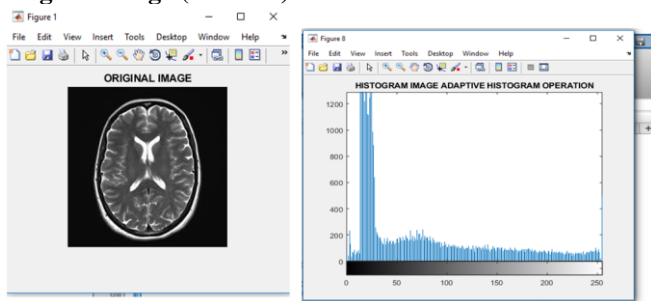**Figure 1:**
Original Image (HIAHO)
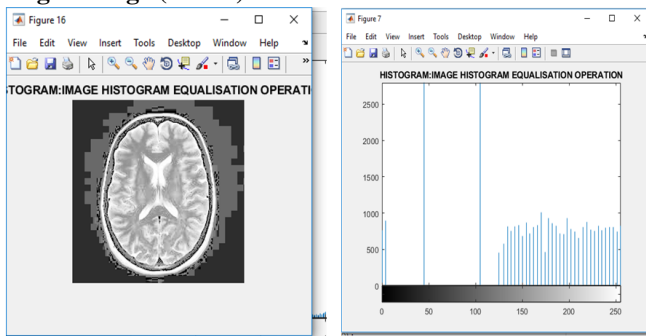

Figure 2:
Bright Image (HIEO)

Figure 3:
Contrast Image (HIAO)
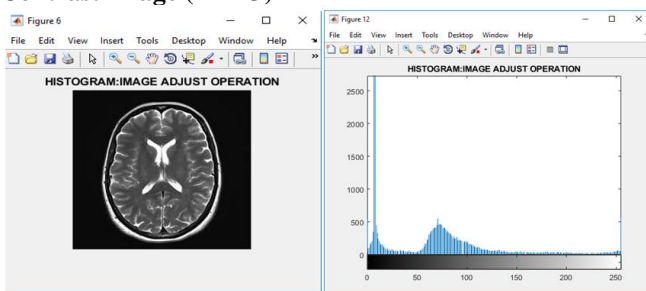
Figure 4:
Bright Image (HOI)
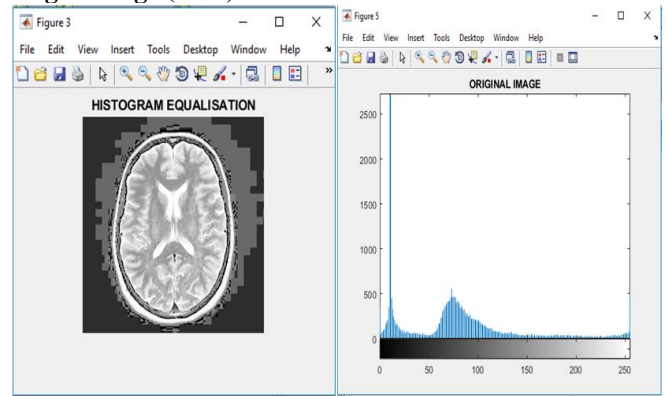
Figure 5:
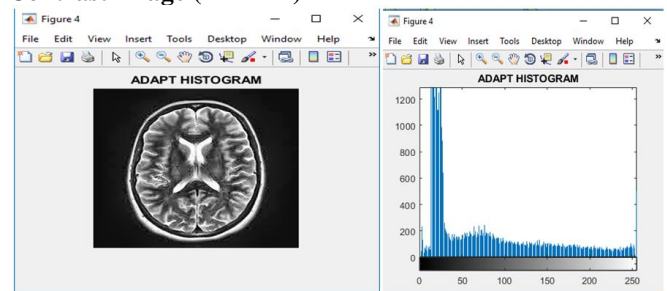**Contrast Image (ADAPT)**

Figure 6:

Figure 7:
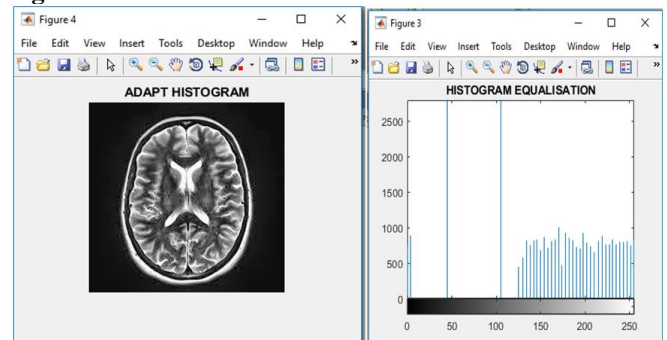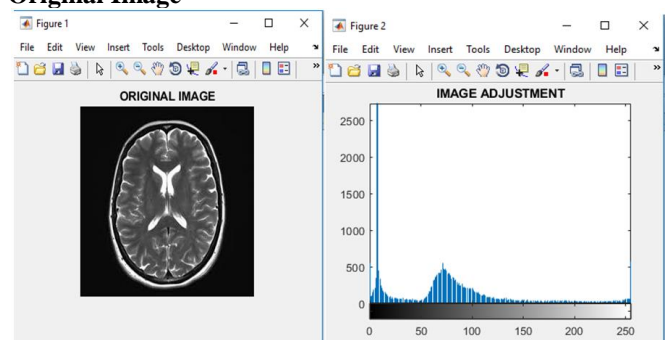**Original Image**

4. Conclusion and Future Work

Image enhancement plays a significant role in image processing. Image enhancement improves the image to provide better representation and information. The main focus of enhancement method is to produce images without severe side effects at the same time maintain input mean

brightness. In this paper presents a study on Image Enhancement with its techniques and advantage in spatial and frequency domain In future work, we can use the multilevel hierarchal clustering on medical x-ray images. This paper presents and effective method for the enhancement of medical grey image. The proposed algorithm provides best range over selecting enhancement level of image. The result shows that the proposed method provide accuracy range of (0, 2000). Future work in this paper involves applying proposed method to 3D medical image involves applying proposed.

References

[1]. Rajesh G, Bhawna M, Sheetal Garg,"Histogram Equalization Techniques for Image Enhancement", IJECT Vol. 2, Issue 1, March2011.

[2]. X. Fang, J. Liu, W. Gu and Y. Tang, "A Method to Improve the Image Enhancement Result based on Image Fusion, " Feb 2012.

[3]. S.S.Chong et al. Faculty of Engineering & Technology, Multimedia University, Melaka, Malaysia "Modified HL Contrast Enhancement Technique for Breast Mr Image", IEEE International Conference on Signal and Image Processing Applications (ICSIPA), "March 2013.

[4]. Agarwal, T.K. et al. " Modified Histogram based contrast enhancement using Homomorphism Filtering for medical images", Advance Computing Conference (IACC), 2014 IEEE International on 1-22 Feb. 2014

[5]. Shikha Mahajan, Richa Dogra "A Review on Image Enhancement Techniques" International Journal of Engineering and Innovative Technology (IJEIT)|Volume 4, Issue 11, May 2015

[6]. Zhijun Yao; Zhongyuan Lai; Chun Wang "Image Enhancement Based on Equal Area Dualistic Sub-image and Non-parametric Modified Histogram Equalization Method" International Symposium on Computational Intelligence and Design (ISCID) IEEE May 2016.

[7]. Mehadi Jafari and Shohresh Kasaei, " Automatic Brain Tissue Detection in MRI Images using seeded Region Growing segmentation, " Apr 2017.

[8]. Sangeet Saha et al. Apr 2018, "Image processing and cryptography, Improvement of pictorial information such as satellite imaging, medical imaging, "Apr 2018.

[9]. Rizwan Asif, M., Chun, Q., Sajid Hussian, Fareed Sadiq, M., Subhan Khan.: Multinational vehicle license plate detection in complex backgrounds. Visual communication image representation 46, 176-186 (2017)

[10]. Bhusan, N.: Automatic Traffic surveillance using Video Tracking. In: 7th International Conference on Communication, Computing and Virtualization, Procedia Computer Science, . 79, 402 - 409 (2015)

[11]. J.-L. Tan, S.A. Abu-Bakar, M.M. Mokji, License plate localization based on edge geometrical features using morphological approach, In: 20th IEEE International Conference on Image Processing (ICIP), pp, 4549 – 4553 (2013)

[12]. P. Prabhakar, P. Anuparma, A novel design for vehicle license plate detection and recognition, In: 2nd IEEE International conference on Current Trends in Engineering and Technology (ICCTET), pp 7-12 (2014)