International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-2, December 2019

Contrast Enhancementof MRI Images using AHE and CLAHE Techniques

C. Rubini, N. Pavithra

Abstract —Medical images require image enhancement, a category of image processing which provides better visualization that make diagnostic more accurate. The most commonly used method for improving the quality of medical image is Contrast enhancement.The main objective is to eliminate the use of contrast dye during the process of MRI scan and to find the parameters MSE, PSNR, AMBE and contrast and compare the result. The histogram equalization (HE) is the widely accepted method which is not productive when the contrast nature differs across the image. Adaptive Histogram Equalization (AHE) overcomes this limitation by considering and developing the mapping for each pixel from the histogram in a neighboring window. Another suitable technique is CLAHE. CLAHE is a refinement of AHE where the enhancement calculation is modified by imposing a user specified level to the height of local histogram. The enhancement is thereby reduced in very uniform areas of the image, which prevents over enhancement of noise and reduces the edge shadowing effect of unlimited AHE. After enhancing the image using AHE and CLAHE the comparison of their parameters is performed.

Keywords—Contrast Enhancement, Magnetic Resonance Imaging, Histogram Equalization, Adaptive Histogram Equalization, Contrast Limited Adaptive Histogram Equalization, Cumulative Distribution Function, Absolute Mean Brightness Error, Fluid Attenuated Inversion Recovery

I. INTRODUCTION

MRI is a medical imaging technique which is widely used to examine the internal organs of the human body. Its uses strong and uniform magnetic field. MRI does not involve ionizing radiation which made it differ from CT and PET scans. If the CT or X-ray does not give clear picture about a patient condition, then the doctor should prescribed MRI. Compared with other scanning procedure, MRI takes longer time and it is louder which generally need the patient to enter a narrow tube. The strong magnetic field produced by it, will align the hydrogen atoms in same direction. It can be used to diagnose brain tumour, stroke, multiple sclerosis, developmental anomalies, evaluate the organs of chest and abdomen. The resultant images can be reviewed on a computer and can be printed or uploaded to a cloud. Image enhancement plays an important role which helps for proper diagnosis by providing very good quality images of the defective parts. For denoising technique mean and median filter is used based on different pixel values which works better for salt & pepper noise and Gaussian noise.

Revised Manuscript Received on December 30, 2019.
***** Correspondence Author

C. Rubini*, Electrical and Electronics Engineering, M.Kumarasamy College of Engineering, Karur,India.Email:rubini.csekar@gmail.com

N.Pavithra,Electronics and Communication Engineering, The Kavery Engineering College, Salem, India. Email: paviece32@gmail.com

Adaptive histogram equalization is the widelyused method of contrast enhancement. In phase-I denoising of MRI image is done which then followed by Enhancement Technique.

A. Block diagram

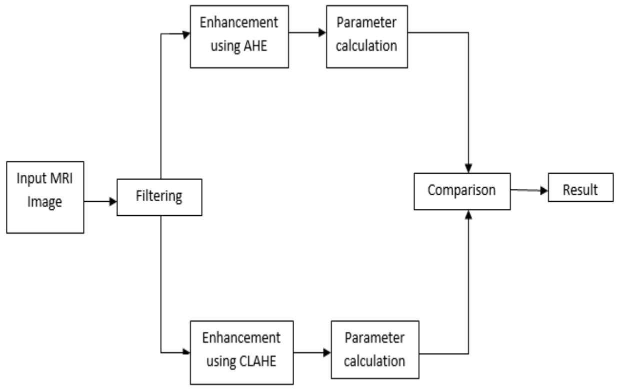


Fig.2.Block Diagram

B. Filtering

Filtering in image processing is a main function that is used to accomplish interpolation, noise reduction, and resampling etc. Most of the MRI images are affected by impulse noise, due to various factors like faulty switching and environmental conditions. Combination of mean and median filter for different pixel value is used to eliminate the noise in MRI images. Among all the type of filters, the simplest low pass filter is Mean filter. Here, Arithmetic mean filter is used to eliminate the noise. By using median filter, the image details at the edge are preserved while removing noise. It works by go through the picture pixel by pixel and replacing each with the median value of neighbouring pixel

C. AHE - Adaptive Histogram Equalization

AHE **(Adaptive Histogram Equalization)** is a digital image processing technique which enhances the contrast of input image.It varies from normal HE by computing numerous histograms and each correlate to a specific region and utilizes them to reconstruct the brightness value of the image. Thus it enhances the local contrast of the input image and results in better quality for visualization.

D. CLAHE - Contrast Limited Adaptive Histogram Equalization

CLAHE is an advanced form of AHE. It prevents the over amplification of noise which results in AHE technique. CLAHE uses contrast amplification limiting procedure that is applied for each neighbouring pixel which then forms a transformation function in order to reduce the noise problem.

E. Parameters Calculated

- **Absolute Mean Brightness Error(AMBE)**

$$AMBE = |E(A) - E(B)|$$

where E(A) and E(B) is the input mean and output mean brightness respectively.

AMBE is lower whichindicates better brightness preservation.

- **Contrast**

It is the difference in luminance and/or color that makes an object distinguishable.

Contrast = (Imax-Imin) / (Imax+Imin)

where I is an output image.

- **Mean-Squared Error (MSE)**

err = immse(A , B)

where A and Bare arrays of any dimension which should be of the same size and class.

- **Peak Signal to Noise Ratio (PSNR)**

If PSNR is higher, the quality of the resultant image (compressed or reconstructed) is better.

F. Flow Diagram

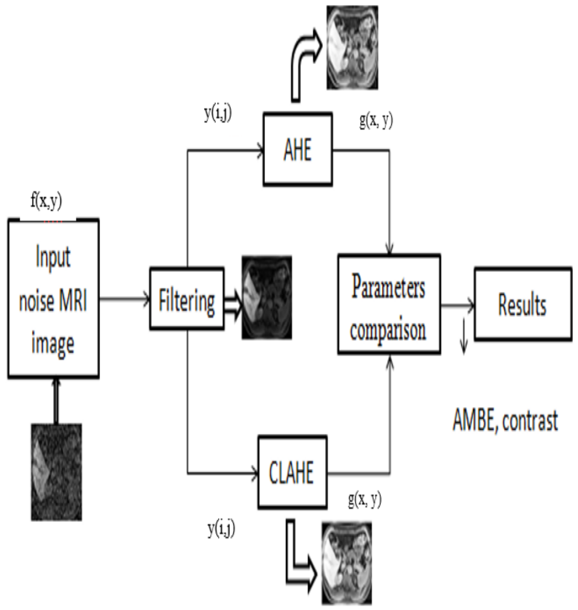


Fig.3. Flow Diagram

G. SOFTWARE TOOL USED

MATLAB (matrix laboratory) Version: 8.1.0.604(R2013a) is used here because of the following advantages.

- Used to de-noise and enhance the medical MRI image
- It saves processing time
- Improves the accuracy of MRI image for easy diagnosis

H. Algorithm for AHE

Step 1: Read the input noise image.

Step 2: Apply mean and median filter

$f(a,b)= (1/mn) \sum_{(s,t)\in Sab} g(s,t)$

$f(a,b) = median_{(s,t)\in Sab}\{g(s,t)\}$

Step 3: Find the frequency counts for each pixel value.

Step 4: Determine the probability of each occurrence using probability function.

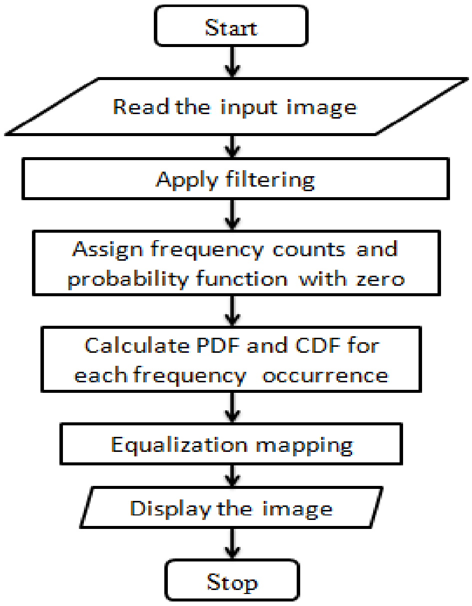
probf(value)=freq(value)/numofpixels;

Step 5: Calculate cumulative distribution probability for each pixel value.

probc(i)=sum/numofpixels;

Step 6: the enhanced image.

I. Flowchart



J. Algorithm for CLAHE

Step 1: Read the input image.

Step 2: Apply mean and median filter.

$f(a,b)= (1/mn) \sum_{(s,t)\in Sab} g(s,t)$

$f(a,b) = median_{(s,t)\in Sab}\{g(s,t)\}$

Step 3:Find the frequency counts for each pixel value.

Step 4:Determine the probability of each occurrence using probability function.

Step 5:Calculate cumulative distribution probability for each pixel value.

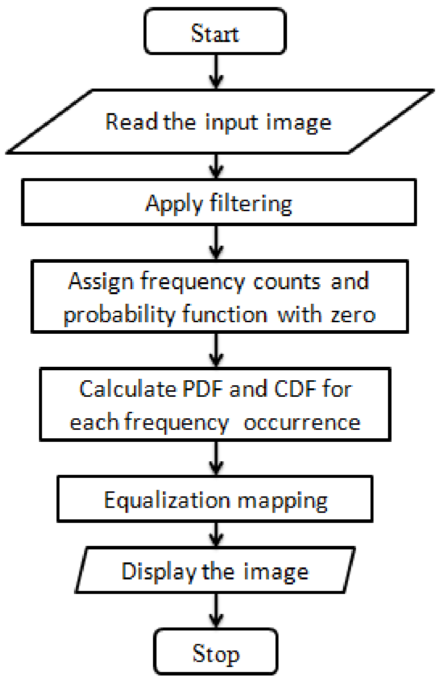
Step 6: Perform equalization mapping for all pixels.

pval = img(i,j)+1

ieqv(i,j) = ieqvhist(pval)-1

Step 7: Display the enhanced image.

K. Flowchart



II. EXPERIMENTAL RESULTS

A. Input Image

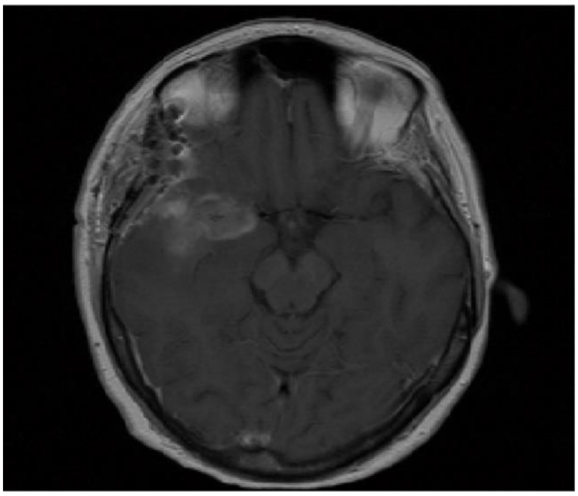


Fig.4. Input Image

B. Enhanced AHE Image

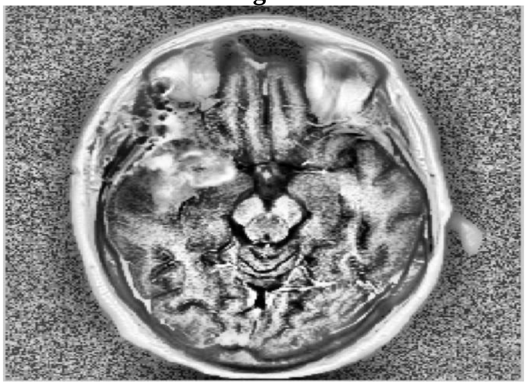


Fig.5. Enhanced AHE Image

C. Enhanced CLAHE Image

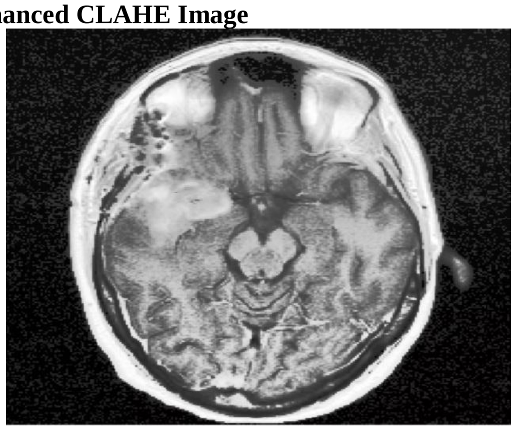


Fig.6. Enhanced CLAHE image

D. Result Analysis

AHE:

Contrast	255.0000
MSE	12859.02
PSNR	55.169529
Normalized Cross-Correlation	2.323055
Average Difference	-100.853745
SSIM	0.114144
Max Difference	37.0000

CLAHE:

Contrast	131.0000
MSE	4053.11308
PSNR	60.18372
Normalized Cross-Correlation	1.887236
Average Difference	-61.98735
SSIM	0.227966
Max Difference	0.0000

III. CONCLUSION

Thegeneralizedformofadaptivecontrastenhancementprovides considerable flexibility, largely through the cumulating function. The Enhancement using AHE technique produces good results but with the ultimate enhancement of minute background noise present in the image.

However, slow speed and the over enhancementofnoiseisproducedinrelativelyhomogeneousregionaretwoproblems of AHE. CLAHE overcomes this drawback since it reduces the over amplification of noise which results in AHE technique. In case of enhancement using CLAHE technique, since the contrast of the image is limited, a clear enhancedimage without noise is obtained. The calculated parameters AMBE and contrast produces more efficient results for CLAHE than AHE technique. Hence for practice, CLAHE technique gives better and effective results when compared to AHE technique.

REFERENCES

1. Senthilkumaran N, “Histogram equalization on image enhancement using MRI images”, IEEE World Congress on Computing and communication technologies 2014.
2. RajilathBabu A.K, “Contrast enhancement of MRI image: a review”, international journal of engineering technology and advanced engineering, vol.5, issue 6, June 2015.
3. Klaus D. Toennis, Guide to medical image analysis, 2nd edition, Springer-Verlog London Ltd., 2017.
4. Pardeep,”Global and Localized Histogram equalization of an image”, international journal of computational engineering research, Vol.2, 2012
5. Hardeep Kaur, “MRI brain image enhancement using Histogram equalization techniques”, IEEE WiSPNET 2016 conference
6. Mandeepkaur and Ishdeep single(2015), “A Dualistic sub-image Histogram equalization and segmentation technique with NN for medical images”, International images of medical and science, Vol-05, pp.15-19
7. Neetu Mittal (2012), ‘Automatic Contrast Enhancement of Low Contrast Images using MATLAB’, International Journal of Advanced Research in Computer Science’, Vol-3, No.1
8. Samkit Jain, Prof. RatneshDubey and Dr.VineetRichhariya (2015), International Journal of Advanced Research in Computer Science and Software Engineering, Vol-5

AUTHORS PROFILE

Mrs.C. Rubini, Assistant Professor, Department of Electrical and Electronics Engineering, M.Kumarasamy College of Engineering, Karur, Tamilnadu. She has completed her Bachelor’s degree in Electrical and Electronics Engineering from Sona College of Technology, Salem and Master’s degree in Applied Electronics from The Kavery Engineering College, Mecheri, Tamilnadu. Her research areas are Image processing and Renewable energy systems.

Mrs.N. Pavithra, has completed her Bachelor's degree in Electronics and Communication Engineering from P.A College of Engineering and Technology, Pollachi, Tamilnadu and pursuing her Master's degree in The Kavery Engineering College, Mecheri, Tamilnadu. Her area of interest includes Image processing and IoT.