International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 2 Issue 4, April-2013, pp: (69-73), Available online at: www.erpublications.com

Histogram Based Denoising and Equalization of Bio-Medical Images

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Abstract: Bio-medical images which are mostly in the form of x-ray, are often contaminated with noise. They are most important tool to visualize unseen part of human body. It is not possible to view such part of bio-medical images where both foreground and background are both dark and white. In this paper we have developed an efficient method which firstly denoise the image and then enhance the global contrast of it, thus providing the tool for better visualization. In our work we have implemented adaptive neuro fuzzy inference system for denoising the image and later histogram equalization was employed for recognizing between back ground and fore ground.

Keywords: Adaptive Neuro-Fuzzy Inference System, Histogram Equalization, Image processing.

Introduction

Images play a vital role in diagnosing. Bio-medical images are often in the form of X-rays in which colors achived are a paleete of whites and black, different type of colors give the physician an idea of the type of density that he or she is observing. Therefore white structure are likely to represent bone or water and black indicate air. When pathologies are present in an image, trying to delimit the area of the lesion or object of interest may be a challenge, because different structure are usually layered with one another. With having almost same contrast regin it is almost critical for achieving accurate diagnosis. More ever it is also very important to denoise bio-medical images.

Image processing

In medical field, image processing plays a vital role in diagnosing diseases and the images used for processing must be a denoised one. Denoising of images comprises of three phases- preprocessing, training and testing. In our work, we utilize X-ray images and improve their quality.

A. Pre-processing

In pre-processing phase, the image is applied to the multi-wavelet transformation based on windows to generate its duplicate image. In this multi-wavelet transformation, the noisy image is processed and a window of pixels is generated. Subsequently, the obtained window of pixels is converted into multi-wavelet transform domain using :

$$W(i, j) = F_{GHM}(i, j) \,.\, w_x(i, j) \,.\, F^T_{GHM}(i, j)$$
$$W'(i, j) = F_{GHM}(i, j) \,.\, w'_y(i, j) \,.\, F^T_{GHM}(i, j)$$

where, $0 \le i \le W_M - 1$, $0 \le j \le W_N - 1$ and W_M, W_N represent the window size. Here, F_{GHM} is the concatenated filter co-efficient of the GHM multi-wavelet transformation.

B. Training

Adaptive Neuro-Fuzzy Inference System is a kind of neural network which integrates both neural network and fuzzy logic principles. It has the potential to capture the benefits of both in a single framework.

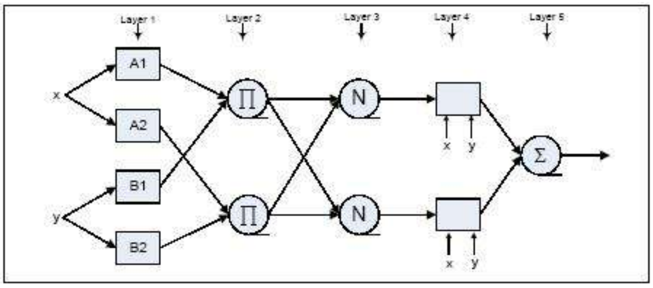

Fig.1: ANIFS structure

We have supposed that our Fuzzy Inference System (FIS) have two inputs and one output. Each input have two fuzzy sets A_1, A_2 and B_1, B_2. So, the rule based system has two if-then rules of Takagi - Sugeno's type which are illustrated as follows:

If x is A_i and y is B_i,
then, $f_i = p_i x + q_i y + r_i$
r = 1, 2

Where f_i is the output and p_i, q_i and r_i are the designed parameters that are assigned during the training algorithm of the ANFIS. Output of each node in every layer is denoted by O^1_i where i specifies the number of neuron in the next layer and l is the layer number.
The training efficiency is improved by employing a hybrid learning algorithm to justify the parameters of input and output membership functions. The output of ANFIS will be a linear combination of the consequent parameters. So, the output can be written as :-

$$f = W'_1 f_1 = W'_2 f_2$$

ANFIS utilizes hybrid learning algorithm in which the least square method is used to identify the consequent parameters in the forward pass and the gradient descent method is applied to determine the premise parameters in the backward pass.

C. Testing

Here the thresholding operation is performed. After the thresholding operation, the image is transformed back to the spatial domain from the frequency domain by employing the inverse multi wavelet transformation to the obtained frequency domain constraints and the denoised image is obtained.
The performance has been evaluated for the image which is corrupted through the AWGN with different noise levels by calculating the PSNR.

$$PSNR\,(I_{WG}) = 20\,Log_{10}\left(\frac{M-1}{\sqrt{\frac{1}{MN}\sum_{m=0}^{M-1}\sum_{n=0}^{N-1}(I(m,n) - I_{wg}(m,n))^2}}\right)$$

Fig2: Original noisy image

Fig3: Retrieved image

Histogram Equalization

Histogram equalization is a technique for adjusting image intensities to enhance contrast. Image histogram equalization is a well-known automatic gray level correction which enhances efficiently image contrast by uniforming its gray levels distribution. It is done by scaling each gray level with the cumulative histogram of the initial image. Let p be a given image represented as a m_r by m_c matrix of integer pixel intensities ranging from 0 to L − 1. L is the number of possible intensity values, often 256. Let p denote the normalized histogram of f with a bin for each possible intensity. So

$$p_n = \frac{\text{number of pixels with intensity } n}{\text{total number of pixels}}$$
$$n = 0, 1, ..., L - 1.$$

The histogram equalized image g will be defined by

$$g_{i,j} = \text{floor}\left((L-1)\sum_{n=0}^{F_{i,j}} p_n\right)$$

where floor() rounds down to the nearest integer.

Methods of histogram equalization

There are a number of different types of histogram equalization algorithms, such as cumulative histogram equalization, normalized cumulative histogram equalization, and localized equalization. Here is a list of different histogram equalization methods:

- Histogram expansion
- Local area histogram equalization (LAHE)
- Cumulative histogram equalization
- Par sectioning
- Odd sectioning

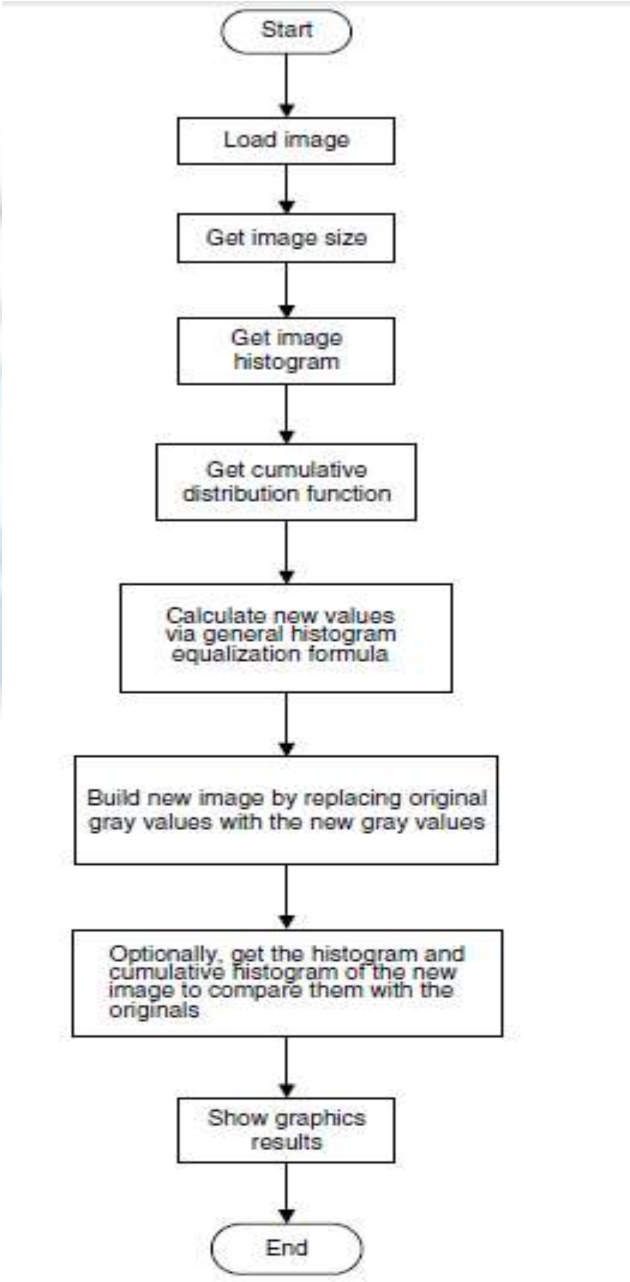

Figure 4: Algorithm implemented

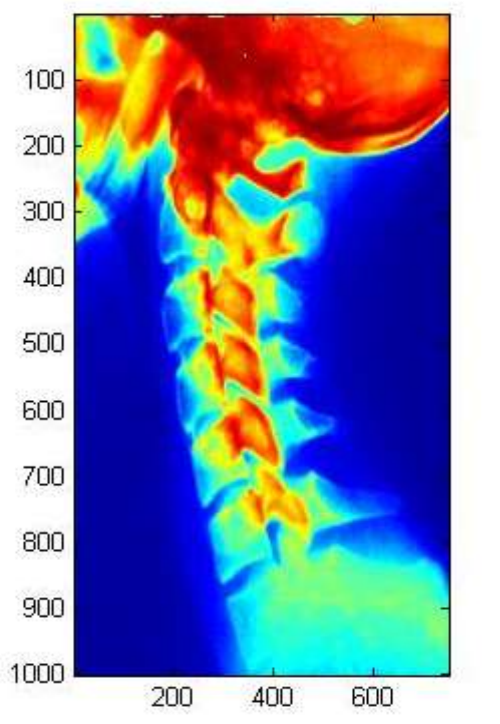

Figure 5: Sample image

Fig 6. (a)Histogram equalized image

Fig 6. (b)Histogram equalized image

Conclusion/Result

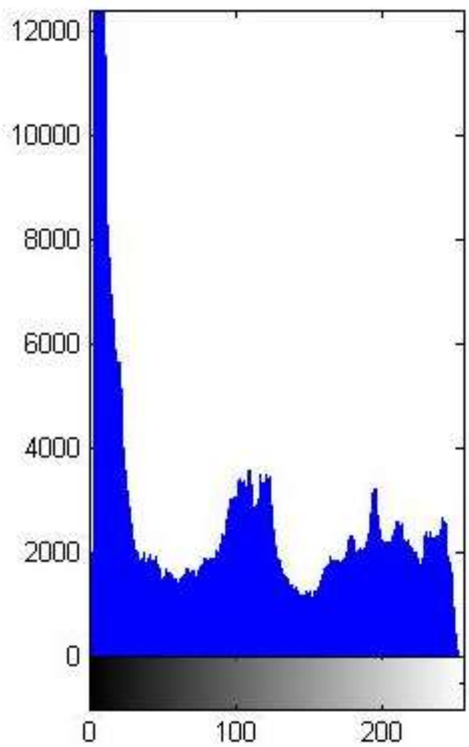

Fig 7: Histogram of sample image

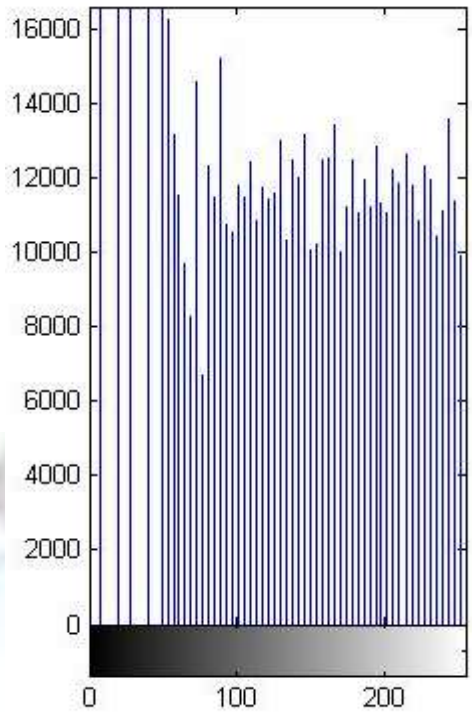

Fig 8: Histogram of enhanced image

Finally, it can be concluded from the above work that image enhancement using histogram equalization is best suited for bio-medical images. All programming were done on Matlab 7.0

Acknowledgment

The authors gratefully acknowledge "International Journal of Enhanced Research in Science Technology and Engineering, ISSN: 2319-7463", and ER Publications for providing a wonderful platform to present there research work.

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