



Image Denoising Techniques

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Abstract-Magnetic Resonance Imaging (MRI) is beneficial and effective diagnostic tool in analysis, clinical investigation, and unwellness identification since it provides each chemical and physiological info regarding the tissue underneath investigation. however once noise get introduced in images, it decreases the image quality, Image analysis and becomes tough to diagnose its accurately. A trade off between noise reduction & preservation of actual image options must build in such manner that enhance the diagnostically relevant image content. so noise reduction remains difficult task. This paper proposes wavelet domain denoising for removal of Rician noise from MR Image. This methodology heavily depends on alternative of threshold parameter that successively determines the potency of denoising.

Keywords: MR images, Rician noise, Thresholding, Denoising

I. INTRODUCTION

MRI is a Magnetic resonance imaging technique used to provide highly detailed images of tissues and organs in human body. MRI is primarily used for assessing the pathological or other physiological alterations of living tissue. MRI provides information that different from other imaging modalities such as X-ray and computed tomography (CT) in such a manner that it can characterize and discriminate among tissues using biochemical and physical properties. Also, without moving the patient it can produce sectional images of equivalent resolution in any projection which obtains images in multiple planes. Thus it adds to its versatility and diagnostic utility and offers special advantages for radiation and surgical treatment planning [19].

The inherent flexibility of MRI also allows its application in many clinical tasks other than imaging static anatomy. These includes imaging blood vessel without contrast agents, measures diffusion in the tissues, measure tissue temperature, cardiac imaging. For clinical diagnosis, the visual quality of magnetic resonance images plays an important role which can be seriously degraded by existing noise during acquisition process. During acquisition or transmission MRI images are corrupted with noise and thus it hinders the medical diagnosis based on these images [19].

Despite significant improvements in recent year, MRI is limited by its spatial resolution and long imaging time. MR image often suffer from low signal to noise ratio (SNR) especially in cardiac and brain image. Noise in MRI follow Rician Distribution and thus limits the visual inspection and also this is problematic for further tasks such as segmentation of important features, classification of images for computer, 3 -dimensional image reconstruction and image registration. The presence of noise is not only produces undesirable visual quality but also it lowers the visibility of low contrast object. Thus noise removal is essential in medical imaging applications in order to enhance and recover fine details that may be hidden within data. [2]

In general, there are two ways to reduce the noise in the images .One is to acquire the data several times and average they but it increases the acquisition time. Another way is to denoise the image by using post processing methods. In the literature, different approaches to denoise the image have been explained [19].

II. DENOISING

Denoising is the process of removing noise from signal. Noise reduction technique are conceptually very similar regardless of the signal being processed, but a previous data of the characteristics of an expected signal can mean the implementations of these techniques vary greatly depending on the type of signals. Image denoising is often used in field of photography or publishing where an image was somehow degraded but needs to be improved before it can be printed. For application we'd like to know something about the degradation process in order to develop a model for it.

When we have a model for the degradation process, the inverse method will be applied to the image to restore it back to the original form. This type of image restoration is often used in space exploration to help eliminate artifacts generated by mechanical jitter in a spacecraft or to compensate for distortion in the optical system of a telescope. Image denoising finds application in fields such as astronomy where the resolution limitations are severe, in medical imaging where the physical requirement for 2 high quality imaging are needed for analyzing images of unique events, and in the forensic science where potentially useful photographic evidence is sometimes of extremely bad quality .Noise can be random or white noise with no coherence or coherent noise introduced by the devices processing algorithm In the case of photographic film and magnetic tape noise (both visible and audible) is introduced due to the grain structure of the

medium. In photographic film, the size of the grain in the film determines the film's sensitivity, additional sensitive film having large sized grain. In magnetic tape larger the grain of the magnetic particles, the more prone the medium is to the noise.

III. VARIETY OF NOISE

A. Gaussian Noise

Gaussian noise is statistical noise that has a probability density function (abbreviated pdf) of the normal distribution (also known as Gaussian distribution). In other word, the value that the noise can take on are Gaussian-distributed. It's most commonly used additive white noise to yield additive white Gaussian noise (AWGN) Gaussian noise is properly defined as the noise with a Gaussian amplitude distribution. This say nothing of the correlation of the noise in time or of the spectral density of the noise. Labeling Gaussian noise as 'white' describes the correlation of the noise. It is necessary to use the term "white Gaussian noise" to be correct.

B. Salt & Pepper Noise

Salt and pepper noise is an impulse type of noise, which is also referred to intensity spike. This is caused generally due to errors in data transmission. It has only 2 possible value, a and b. The probability of each is typically less than 0.1. The corrupted pixels area are set alternatively to the minimum or to the maximum value, giving the image a "salt and pepper" like appearance. Unaffected pixels stay unchanged. For an eight-bit image, the typical value for pepper noise is 0 and for salt noise 255. The salt and pepper noise is mostly caused by malfunctioning of pixel elements in the camera sensor, faulty memory locations, or timing errors in the digitization process.

C. Rician noise

It is the multiplicative noise. Magnetic resonance magnitude (MRI) image data are usually modeled by Rician distribution. The term Rician noise is used to refer to the error between the underlying image intensity and the observed data. Rician noise is not zero mean and the mean depends on the local intensity in the image. The Rician probability density function is given by,

$$p(x) = \frac{x}{\sigma^2} \exp\left(-\frac{x^2 + A^2}{2\sigma^2}\right) I_0\left(\frac{x A}{\sigma^2}\right)$$

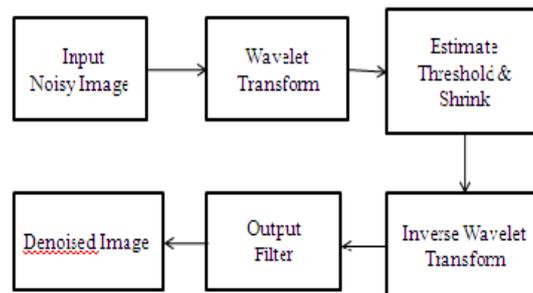
Where: σ is a standard deviation of Gaussian distribution that underlies the Rician distribution noise

$$A^2 = A_1^2 + A_2^2$$

Where A_1 and A_2 are the mean values of two independent Gaussian components. I_0 is the modified 0th-order Bessel function of the first kind. Also, rician noise is signal dependent and particularly problematic in high resolution, low signal to noise ratio regime where it not only causes random fluctuations but also introduces as signal dependent bias to the data that reduces image contrast. As bias field signal is low frequency signal which corrupts MRI images because inhomogenities in the magnetic field of MRI machines. It blurs the images and reduces the high frequency content of image such as edge, contours and also alters the intensity values of image pixels. Because of this tissues have different grey level distribution across image. Image processing algorithm like segmentation, classification use the grey level values of that image pixels which will not give satisfactory result. The pre-processing is required for correction of bias field signal before submitting corrupted MRI to such algorithm.[16]

Rician noise affects the image in both quantitative and qualitative manner and thus it hinders image analysis, interpretation and feature detection [16].So denoising method is required which removes this noise. Denoising is nothing but the removing noise from image while retaining the original quality of the image. The great challenge of image denoising is how to preserve the edges and all fine details of an image while suppression of noise. It still remains challenge for researchers as noise removal introduces artifacts and causes blurring of the images [1]. So, it is necessary to developed an efficient denoising technique to avoid such data corruption.

IV. BLOCK DIAGRAM



Denoisy MRI images, first take MRI image which should be in the form of jpg or png. Add noise in the original image to obtain noisy image. Using wavelet transform ,wavelet decomposition is done using discrete wavelet transform. And then apply thresholding technique to this components accorading to shrinkage rule and its type. By doing this noisy components can be easily remove from MRI image. Then inveret the discrete wavelet transform, to obtain denoisy image.

V. RESULT

We used MATLAB setting to develop denoising algorithm. MATLAB has a wavelet toolbox and functions which are very convenient to DWT. A usual way to denoise is find a processed image such that it minimizes mean sq. error MSE and will increase the value of the PSNR.

For study purpose, we've taken ten images, keeping MRI images same we've varied noise added to image, wavelet family and threshold type (hard & soft Thresholding). After observing the results we can conclude that PSNR for Gaussian noise and salt & pepper noise is less. Keeping other parameters (Wavelet family and Threshold type) constant, PSNR for rician noise is best. Considering rician noise and thresholding type if wavelet family is varied, finally obtain denoisy image.

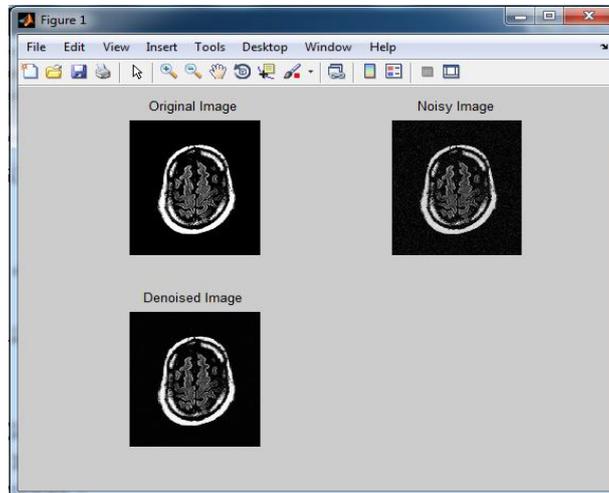


Fig: Denoising of MRI by Soft thresholding using db4 for rician noise

VI. CONCLUSION

In this paper, we have presented the denoising method based on wavelet thresholding which offers top quality and flexibility for noise problem of signal and images. By comparing soft and hard thresholding, it is seen that soft thresholding is better compared to hard thresholding when it's used for rician noise.

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