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Investigation of Optimal Wavelet Techniques for De-noising of MRI Brain Abnormal Image

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Abstract

In the field of medical applications, typically obtained medical images like X-ray, CT, MRI etc. consists of noise that reduces the visual quality of an image. Therefore, de-noising is essential during the image acquisition process. Though several methods are available for de-noising the image, the performance metrics of wavelets and threshold values to be used are not optimized for assessing the quality of an image. In this paper, DWT techniques with suitable threshold value and five objective quality metrics are used for de-noising the abnormal MRI brain speckle noise image. Quality metrics like Squared Error Mean (SEM), Peak Signal to Noise Ratio (PSNR), Structural content (SC), Structural Similarity Index Method (SSIM), and Absolute Mean Error (AME) are estimated for de-noised MRI brain image are discussed. The quality of the image is assessed depending on the metrics and wavelet threshold techniques.

Keywords: MRI brain abnormal image, DWT , threshold, Squared Error Mean (SEM), Peak Signal to Noise Ratio (PSNR), Structural content (SC), Structural Similarity Index Metrics (SSIM), Absolute Mean Error (AME).

1. INTRODUCTION

Elimination of noise from images in the area of Bio-medical image processing is required because of poor visual quality[1,4] due to noise. Medical images like X-ray, CT, MRI are affected by noise during its process can be detected by using several methods. Some of these methods on other hand provide the blurring images[8]. Hence, the selection of noise removal methods[2] are very crucial in bio-medical image processing.There are many methods to prevent the unwanted signals in images. In this paper, MRI brain abnormal image is de-noised by using different wavelet

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techniques, decomposition levels, with suitable threshold values and quality assessment parameters are used. Generally images are corrupted with additive and multiplicative noises which can be removed by using different filtering methods[6] or wavelets techniques etc. There are different types of wavelets, out of them some discrete wavelet techniques db4, sym4, and bior1.3 are used for de-noising the MRI brain abnormal image.The wavelet transform brings revolutionary influence in image processing. In DWT, images can decomposed into approximation coefficients and detailed coefficients along with horizontal, vertical and diagonal directions[4,7] by passing through complementry filters. In this section considered the 3 levels of decomposition and suitable threshold values on speckle noised MRI abnormal image. This type of noise appears in coherent imaging systems like RADAR, SAR, ultrasound and MRI[3,5].

2. Noise Estimation Parameters

To obtain percepteal image quality using de-noising technique with wavelet filter performance, the preparatary results are assessed accoding to the following noise estimation parameters.

- Squared Error Mean (SEM):

$$SEM = \frac{1}{KL}\sum_{i=1}^{K}\sum_{j=1}^{L}(p(i,j)-q(i,j))^2 \tag{1}$$

- Peak Signal to Noise Ratio (PSNR):

$$PSNR = 20\log_{10}\left(\frac{\max_I}{\sqrt{SEM}}\right) \tag{2}$$

Where max_I is a maximum possible pixel value.

- Structural Similarity Index Method (SSIM):

$$SSIM = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)} \tag{3}$$

- Structural Content (SC):

$$SC = \frac{\sum_{i=1}^{K}\sum_{j=1}^{L}(q(i,j))^2}{\sum_{i=1}^{K}\sum_{j=1}^{L}(p(i,j))^2} \tag{4}$$

- Absolute Mean Error (AME):

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