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# Medical Image Denoising Techniques using Wavelet Transform and its Comparison

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**ABSTRACT**

Medical Image denoising is the elimination of corrupted images which are occurred even as the image is being obtained. Deprivation arrives from blurring due to a range of sources. Denoising is an appearance of bandwidth decrease in the image cause by the defective image arrangement procedure like comparative action between the camera and the entity. With these denoising effects, the captured image can also be spoiled by noises. A noise can be formed in the broadcast owing to a noisy conduit, errors are obtained as data for digital storage. This paper proposes performance comparison of wavelet based image denoising technique with spatial filtering techniques like Linear, Median, Adaptive and Soma. Peak signal to Noise ratio (PSNR) and Similarity Measure (SM) are the two parameters to measure the quality of diverse denoising techniques beside various noises like Gaussian noise, Salt & Pepper noise, Speckle noise and Poisson noise.

**KEY WORDS:** Medical Image denoising, Soft threshold, Wavelet transform, Bayes shrink.

## 1. INTRODUCTION

A noisy image is obtained when the clear input is received, a few aberrations are introduced and it is gone for future meting out. The image obviously tarnished by noise is a conventional setback in the ground of image processing. Images are repeatedly corrupted by way of noise while acquiring, transmission, and retrieving since storage media. For example, numerous dots can be speckled in a photograph acquired with a digital camera under low lighting surroundings. Appearance of dots is due to the real signals getting corrupted by noise (unwanted signals). Whereas in television, arbitrary black and white snow patterns can be seen on the television screens owing to loss of reception. Hence noise corrupts both images and videos. In count, fine particulars in the image may be bewildered with the noise or vice versa. Many image processing algorithms such as an improved non local denoising algorithm, pattern recognition etc. need a clean image to work effectively.

**Discrete Wavelet Transform:** The chief benefit of wavelets over Fourier analysis is, they permit spatial and frequency decree during analysis. Wavelet transform consent to the decomposition of the signal in slight frequency bands whereas trust the basis signals space restricted. Fig.1, shows a two level DWT analysis tree using low pass and high pass analysis filter banks h(-m) and g(-m) in that order. In wavelet decomposition, an input image is decomposed to one low frequency image LL1 and three detail images LH1, HL1 and HH1 as shown in Fig.1. The low frequency image LL1 is further decomposed to four coefficients LL2, LH2, HL2 and HH2. In this work, noises are removed from the coefficients using soft threshold, hard threshold and Bayes shrink techniques.

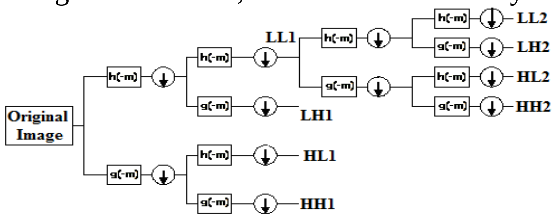


**Figure.1. Two level 2D DWT analysis filter banks**

## 2. PROPOSED TECHNIQUE

In this technique, medical image is considered as input image. Noises like Gaussian noise, Salt & pepper noise, Speckle noise and Poisson noise are added to the input image. Wavelet based filtering techniques like various wavelet based filters like hard threshold, soft threshold and Bayes shrink are applied to remove the noise from the noisy input image.

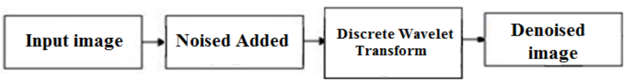


**Figure.2. Proposed algorithm for spatial domain filters**

### Wavelt Based Filtering Techniques

**Soft Threshold:** Soft thresholding is that the coefficients are shrunk when it gets greater than the threshold and it goes towards zero after estimating it to the threshold value. It is defined as below.

$$T_S = \begin{cases} sign(x)\,(|x| - t)\ for\ |x| \geq t \\ 0 \quad in\ all\ other\ regions \end{cases} \qquad (1)$$

The probability should be known to diminish the risk R for Bayesian approach.

**Hard Threshold:** Hard thresholding is a category of overall thresholding. In this technique, thresholds the complete image with a mono thresholded value. This method is applied for image denoising and selecting one threshold value for whole image. This thresholding sets to zero that element whose supreme value is less than the threshold value and neglecting zero elements. The hard-thresholding ($T_H$) kills all the sub-bands smaller than the threshold (t) and leaves the others without changes and is given as

$$T_H = \begin{cases} x \ \text{for} \ |x| \geq t \\ 0 \ \text{in all other regions} \end{cases} \quad (2)$$

Where $t$ is the threshold value.

**Bayes Shrink:** Bayes shrink threshold which minimizes the Bayes risk, unlike the widespread threshold or SURE threshold obtained by minimax rule. This technique is effectual for images together with Gaussian noise. The surveillance replica is expressed as follows:

$$Y = X + V \quad (3)$$

Here Y, X and V are the wavelet transform of the degraded image, original image and the noise components respectively.

## 3. RESULT AND DISCUSSION

In this work, colour medical input image (MRI) of size 256 x 256 is taken as shown in Fig.3. Primarily Gaussian noise is added to the input medical image and it is converted to YUV components and Y component is shown in Fig.4 and 5. DWT is implemented to the corrupted input to one level as shown in Fig.6 and second level is shown in Fig.7. Filtering techniques is functional on the coefficients and the noises are diminished to obtain denoised image as shown in Fig.8. Now salt & pepper noise is applied and the same procedure is repeated to obtain the denoised image as shown in Fig. 9 and 10. Similarly speckle noise and poisson noise are additional for the same image and it is denoised as shown in Figs.11 to 14. In order to justify the proposed medical image work, a colour Lena and house images are taken and the same procedure is done on this image to obtain the denoised image as shown in Figs.15 to 32. Peak signal to Noise ratio (PSNR) and Similarity Measure (SM) are the performance measures to measure the eminence of the denoising methods for Lena image against a variety of noises like Gaussian noise, Salt & Pepper noise, Speckle noise and poisson noise and it is tabulated in table.1.

**Figure.3. Input image (Lena)**

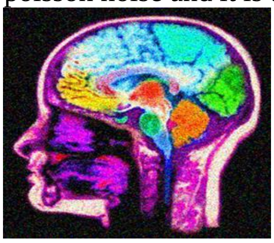

**Figure.4. Gaussian noise added**

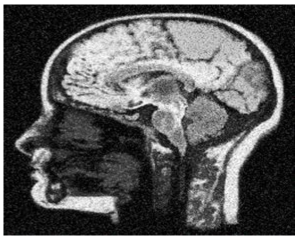

**Figure.5. Y component**

**Figure.6. One level decomposition of Y component**

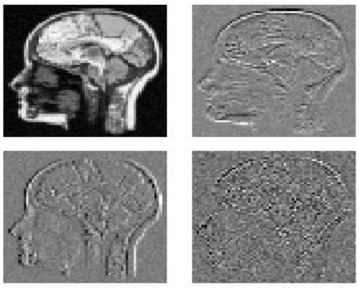

**Figure.7. Two level decomposition of Y component**

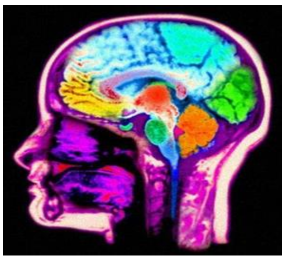

**Figure.8. Denoised image**

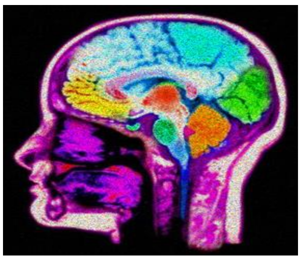

**Figure.9. Salt & Pepper noise added**

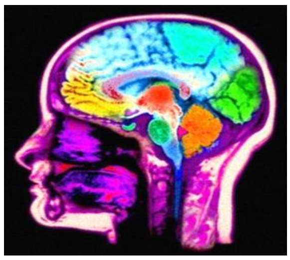

**Figure.10. Denoised image**

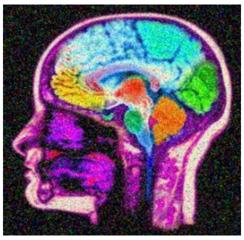

**Figure.11. Speckle noise added**

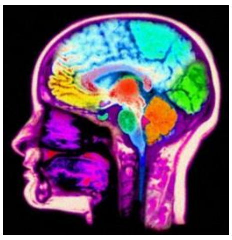

**Figure.12. Denoised image**

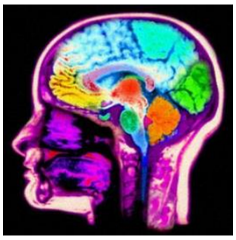

**Figure.13. Poisson noise added**

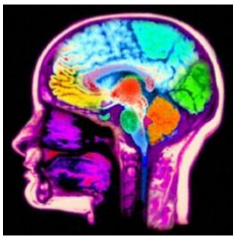

**Figure.14. Denoised image**

**Fig. 15. Input image**

**Fig.16.Gaussian noise**

**Fig. 17. Denoised image**

**Fig.18. Salt & Pepper**

**Fig. 19. Denoised image**

**Fig. 20. Speckle noise**

**Fig. 21. Denoised image**

**Fig. 22. Poisson noise**

**Fig. 23. Denoised image**

**Fig. 24. Input image**

**Fig.25.Gaussian noise**

**Fig. 26. Denoised image**

**Fig.27. Salt & Pepper**

**Fig. 28. Denoised image**

**Fig. 29. Speckle noise**

**Fig. 30. Denoised image**

**Fig. 31. Poisson noise**

**Fig. 32. Denoised image**

**Table.1. Performance comparison of various filters for Lena image**

| **Noise** | **PSNR (dB)** | | | **Similarity Measure** | | |
|---|---|---|---|---|---|---|
| | **Soft Threshold** | **Hard Threshold** | **Bayes Shrink** | **Soft Threshold** | **Hard Threshold** | **Bayes Shrink** |
| **Gaussian Noise** | 43.5903 | 44.0926 | 45.1563 | 0.9245 | 0.9382 | 0.9483 |
| **Salt & Pepper Noise** | 42.9846 | 43.2914 | 44.6147 | 0.9219 | 0.9317 | 0.9405 |
| **Speckle Noise** | 43.3743 | 44.1278 | 45.1950 | 0.9298 | 0.9376 | 0.9410 |
| **Poisson Noise** | 43.7183 | 44.2846 | 45.9285 | 0.9399 | 0.9412 | 0.9528 |

## 4. CONCLUSION

This paper presents the judgment of several colour image denoising techniques like hard threshold, soft threshold and Bayes shrink in wavelet province adjacent to a variety of noises for the medical image. In order to justify the proposed medical image denoising technique various images like lena and house images are taken and obtained the results. The simulation results divulge that this proposed technique can able to eliminate noise in accurate manner. The proposed denoising algorithm performs better for colour image denoising in wavelet domain.

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