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Impact & Analysis of Sure Based Wavelet Demising Approach for Biomedical Images

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Abstract: Image denoising is one of the primary task in medical world. Medical Images obtained through various scans may have an additive noise. The treatment strategy followed by doctors highly depend upon the images obtained. It has to be reliable and noise free for perceiving the information correctly for accurate diagnosis. One of the way is to assume a statistical model for wavelet coefficients. Other way is to describe the process of denoising parameters as the total of nonlinear processes with unknown weights. Then, the mean square error between the original clean image and noise image is estimated which is to be minimized to get expected results. Estimate is in degree two in unknown weights, an accurate and statistically unbiased MSE estimate i.e. SURE estimate is used.

Keywords: Wavelet denoising, SURE, Medical Images

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I. INTRODUCTION

Frequency based approach done at different scales proved less sensitive to noise. The wavelet based approach remove noise, regardless of its frequency content. At the same time wavelet Denoising approach is capable of preserving edges and characteristics of signal. In general, this approach involves three steps:-

i) Linear forward wavelet transform
ii) Non linear thresholding
iii) Linear inverse wavelet transform

Efficiency of wavelet Denoising is highly dependent on thresholding parameter. A small threshold give the result close to input while noisy enough but a large threshold gives the signal with large number of zero coefficients which leads to smooth signal. The problem is to find the optimal threshold such that the mean square error between signal and its estimate is minimized.[1]

There are many thresolding techniques like SUREshrink, VISUShrink,BAYEShrink. They can majorly classified as hard and soft thresolding. BayesShrink performs better than SureShrink in terms of MSE. The reconstruction using BayesShrink is smoother and more visually appealing than the one obtained using SureShrink.[2][3]

The small wavelet coefficients are dominated by noise while the larger wavelet coefficient are less affected and carries larger part of the information. Wavelet transforms has decorrelating properties which make the signal sparse. The wavelet decomposition is done and subbands are obtained. The threshold is calculated globally and applied to the subband or level based wavelet coefficient to remove noise. To ensure that high frequency components pertaining to edges are kept intact, concept of local variance is effectively used.[4][5]

In OWT, child subband is almost double of the size of parent subband. Generally, parent subband is expanded by factor of two. But the filters of DWT causes a shift. The proposed algorithm ensures the alignment of image features between parents and its child. The interscale predictor to provide actual value of child wavelet coefficient but gives an idea of a magnitude. The processing has simple bitwise threshold induced by interscale information.[6][7]

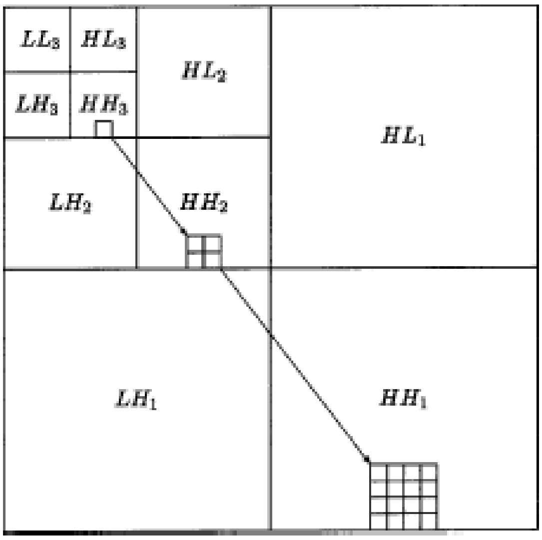

Figure1.1 : Stages of Fully decimated OWT

II. DENOISING APPROACH

The algorithm works in the framework of orthogonal wave transform. It performs an interscale orthogonal transform. It performs an interscale orthogonal wavelet thresolding.

1. A biomedical image is taken as an input.
2. Noise is introduced to check the functionality of the proposed Denoising approach,
3. Most suitable number of iterations is calculated. This is done to prevent denoising in sub bands where the number of samples is below 256 to ensure a reliable statistical analysis. Firstly maximum number of possible iterations is calculated. Then the most suitable number of iterations is calculated.
4. The wavelet transform of the image is calculated using Fourier transform. It uses periodic boundary conditions. The 2D size of the input signal can be arbitrary, at least one dimension of the signal has to be even. First, it is checked that the maximum number of iterations is not exceeded, then wavelet filters are applied. The 1D frequency response of the scaling/wavelet filters is computed where default wavelet type is 'sym8'. Purpose is to obtain the frequency response of analysis scaling filter and wavelet filter, also, synthesis analysis and wavelet filter. Frequency response of analysis wavelet filter is then used to find frequency response of group delay compensation filter associated with wavelet filter. Then, 2D wavelet transform is applied.
5. Noise standard deviation is estimated.
6. For denoising, a normalized 2D Gaussian kernel with a standard deviation is applied on the 2D signal. Then, additive white Gaussian noise is removed using interscale SURE-LET principle. Wavelet coefficients of given subband are calculated using corresponding interscale prediction (Wavelet coefficients of parent associated to wavelet coefficient of noisy signal).
7. The inverse wavelet transform of arbitrary 2D signal is applied using Fourier method. It uses periodic boundary conditions, default assumes maximum levels of decompositions, where default is 'sym8'.

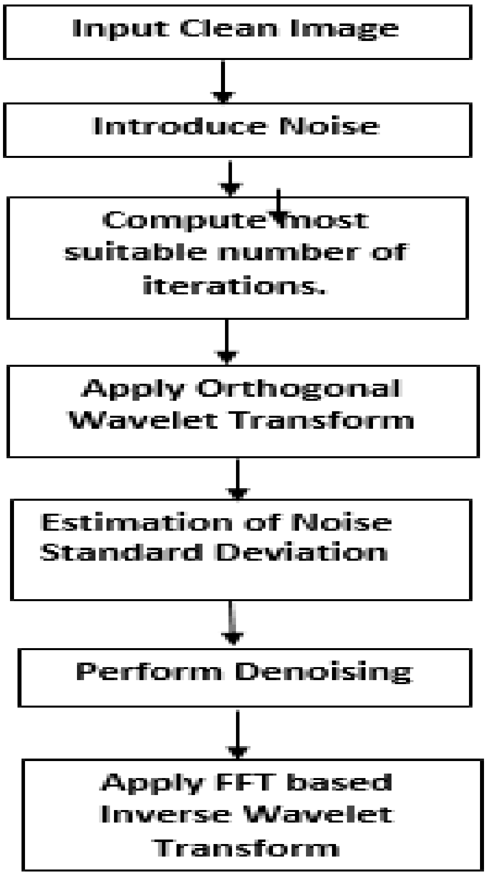

Figure 2.1: Algorithm Flowchart

III. RESULT

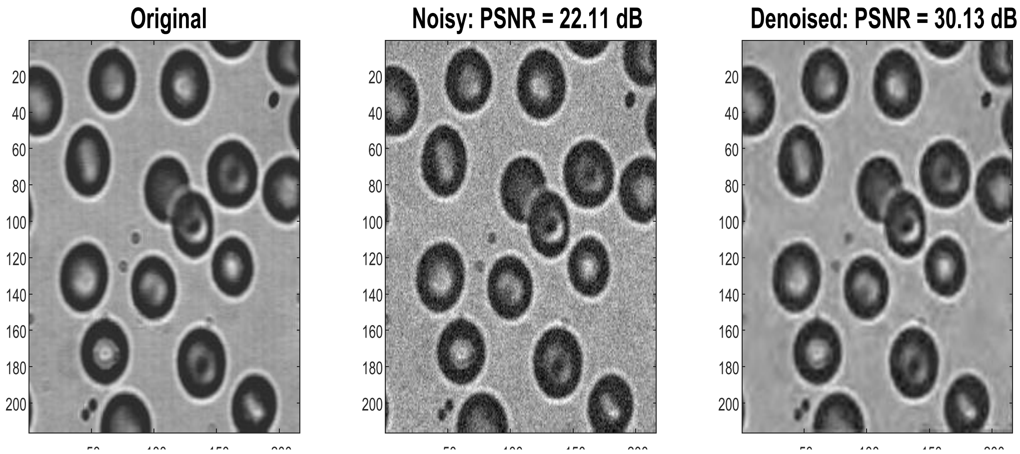

Figure 3.1: Result Images with PSNR

IV. CONCLUSION

The wavelet coefficient in the proposed algorithm is never forced to zero and does not require any prior statistical model creation of wavelet coefficients. The algorithm completely discards interscale correlation though considers interscale dependencies. The group delay between scaling and wavelet filters is handled by GDC. SURE based approach has given best output PSNR of 30.13dB where the noisy had 22.11dB only.

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