CHAPTER 7

CONCLUSION AND FUTURE SCOPE OF THE RESEARCH WORK

7.1 CONCLUSION

Ultrasound images are the most extensively used imaging modality in the medical field to diagnose various abnormalities in human body. However, its usage is restricted due to the existence of speckle noise. Hence the removal of speckle with preservation of fine details is an active area of research. The progress of recent wavelet based approaches is used in recent literature for constructing new adaptive filters for enhancing the quality of US images. This research work investigated new adaptive wavelet filters in the undecimated wavelet domain for enhancing the quality of US images.

The EAWF utilized a homogeneity based weighted variance estimation for determination of adaptive threshold. The incorporation of inter-scale relation in homogeneity measure estimation improved the context selection. This is evident from the improved values of PSNR and EPI measures. Based on the results of EAWF, a new adaptive filter SIIAWF was proposed. Two frameworks were developed to analyze SIIAWF. The first framework SIIAWF[1] utilized a new and improved adaptive thresholding function with an intra- scale measure based signal variance estimation. The new and improved adaptive wavelet thresholding function reduced the fixed bias between the original and reconstructed coefficients and also reduced the number of zero coefficients. Therefore the reconstructed coefficients approximated the original coefficients. The intra-scale measure calculated from the sample mean absolute deviation of the data from their mean, gave a good indication of the local variability of the coefficients. Hence, the variance

estimated using this measure offered a better adaptive threshold, resulting in improved performance of SIIAWF[1]. The second framework SIIAWF[2] performed a two stage filtering. First, a combined inter and intra scale measure based signal variance was estimated and thresholding was done with the new and improved adaptive thresholding function. The combined measures improved the information about the local spatial characteristics of the coefficients. Therefore the estimated variance yielded a better adaptive threshold. The performance of the filter was further improved by adapting the thresholding function with respect to a change in error measure. The changes in error measure reduced the noise further and retained the original information better. The results and comparison revealed that the performance of both frameworks was better than the existing approaches, in all the measures considered.

ISTWF was designed to modify the low magnitude coefficients below the threshold. A new exponential thresholding function was proposed to reduce the small magnitude coefficients gradually to zero. The proposed inter-scale adaptive threshold utilized the parent-child relationship in the adjacent scale subbands. Hence, the small magnitude coefficients at finer scales are retained better, which improved the edge preservation ability of the filter. The results and comparisons indicate that the proposed approach performs better than the existing filtering approaches in noise removal as well as in preserving edges and fine details.

Finally, a fusion based denoising approach for combining SIIAWF and ISTWF was discussed to further improve the quality of ultrasound images. The first level, inter-scale activity based fusion aided in keeping the information of the source images intact. The second level, intra-scale activity based weighted fusion scheme enhanced the quality of the ultrasound images combining the best features of the two filter outputs. The weight measure

utilized the intra-scale correlation of the coefficients and hence improved the feature preservation ability of the filter. As a result, the final fused image resulted in a good quality enhanced image with high PSNR, EPI and contrast enhancement.

Based on the proposed methods it is inferred that fusion based method (FBWF2) outperforms the existing benchmark soft thresholding approach and other proposed approaches. For a set of 30 real samples collected from clinic, the proposed approach yields on an average the following performances: PSNR of 37.17dB, SSIM of 0.8512, ENL of 0.8220 and EPI of 1.4605. The existing soft thresholding approach yields PSNR of 37.67dB, SSIM of 0.8220, ENL of 1.2023 and EPI of 0.3065. The results show that FBWF2 outperform the benchmark soft thresholding algorithm in terms of peak signal to noise ratio by 14.8%, structural similarity index measure by 4.22%, equivalent number of looks by 17.65% and edge preservation index by 49.39% on an average. The improvement on structural similarity measure may be further investigated. Thus it is concluded that the proposed undecimated wavelet based adaptive filters achieve a better performance than the existing fiters.

7.2 FUTURE SCOPE OF THE RESEARCH

The future directions of this research are, to improve the performance of the adaptive wavelet filters with directional wavelet transform. The lack of directional selectivity of DWT is not overcome with UDWT approach. A complex wavelet transform is nearly shift invariant and is a good directional selective transformation technique. Hence adaptive filter with complex wavelet transform can be considered for future development. Also, wavelet adaptive filters for other imaging modalities are to be carried out.