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Analysis of Different Wavelets by Correlation

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Abstract—In today's world, speech is an integral part of digital communication. The removal of noise in analog and digital communication has been a daunting task for many years. Noise is an unwanted signal that hinders communication. There are various methods to help restore a speech from noisy distortions. Wavelets have by now established themselves to be an invaluable accumulation to the analyst's compilation of tools and go on to enjoy a rapidly increasing recognition in their brief account of the signal processing field. Wavelet analysis is competent of enlightening aspects of data that other signal study techniques miss. In addition, it affords a diverse view of data than those obtainable by conventional techniques. Wavelet analysis can often compress or de-noise a signal without appreciable degradation. Study in the field of Wavelets has shown that Wavelet decomposition is a capable method as other methods of denoising. In this paper, the author compares the performances of Daubechies, Coiflet and Symlet Wavelets for different values of their order for an audio signal. Further, the variation of threshold values with correlation has been investigated.

Keywords- Noise, Daubechies

I. INTRODUCTION

In the last few decades Wavelets have become a popular tool for speech processing. The rise in the area of denoising of speech has been due to its use in the area of mobile communication, musical-tones, digital aids, physics, medicine and biology etc. There are many denoising procedures which can be used with different Wavelets. Correct choice of denoising method and Wavelets are the important consideration in improving the quality of an audio signal. The author uses a method which has been presented in their paper 'speech signal noise reduction by Wavelets' [22]. Wavelets are superior to STFT and Fourier Transform because they simultaneously process time and frequency. Also, wavelets work at high frequency which provides fast changing details. The Wavelets can be stretched at high frequency. In the case of low frequency they are applied to slow changing features. Wavelets can easily represent functions for discontinuities and sharp peaks and can work without using complex numbers.

II. CONSIDERATIONS IN THE CHOICE OF A WAVELET

The number of vanishing points is an important criterion in choosing a Wavelet. If there are 'n' vanishing moments, it means the Wavelet coefficients for nth order polynomial will be zero. This implies that any scale upto (n-1)th order can be drawn completely in scaling space. More vanishing points means that the signal can be represented more accurately. Symmetry considerations are useful for providing knowledge about signal phasing.

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The regularity of a wavelet is also useful for smoothness of the reconstructed signal. Daubechies Wavelet comprises of a maximum number of vanishing moments and is not symmetrical in nature. Coiflet and Symlet Wavelets are near-symmetrical in nature. The Coiflet Wavelet has vanishing moments in its scaling function. Exact reconstruction is possible in all three Wavelets.

III. BLOCK DIAGRAM

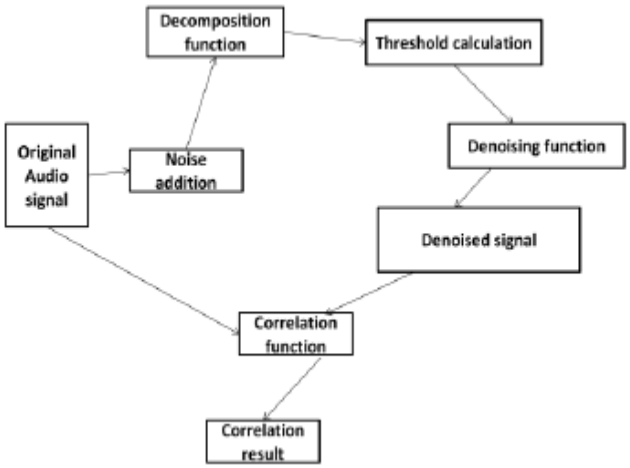

Figure 1: Denoising Method

IV. RESULTS

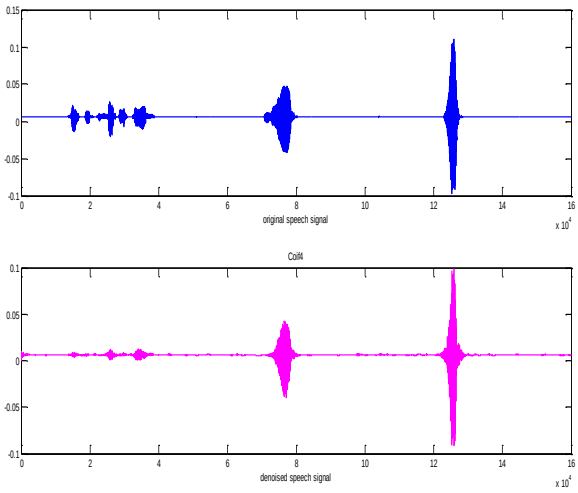

Figure 2: Coiflet Wavelet Audio Signal

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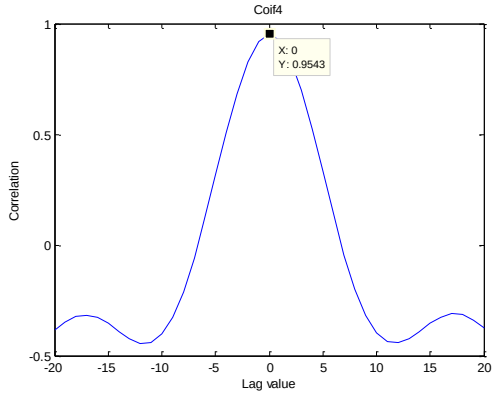

Figure 3: Coiflet Wavelet Audio Signal Correlation Graph

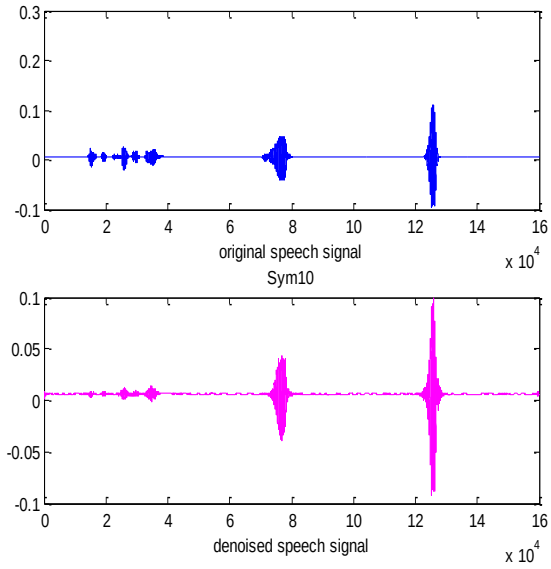

Figure 4: Symlet Wavelet Audio Signal

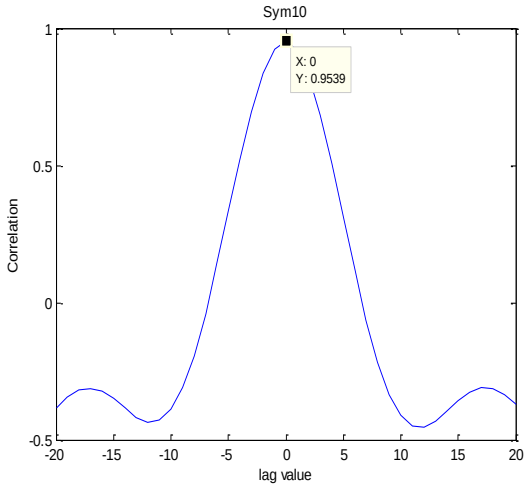

Figure 5: Symlet Wavelet Audio Signal Correlation Graph

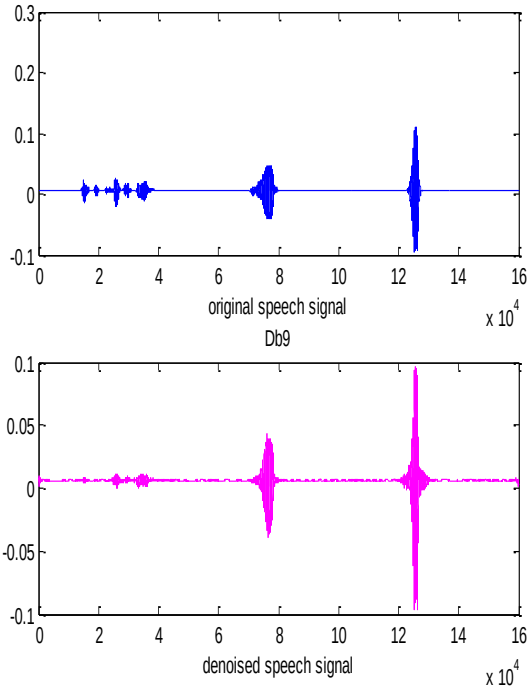

Figure 6: Daubechies Wavelet Audio Signal

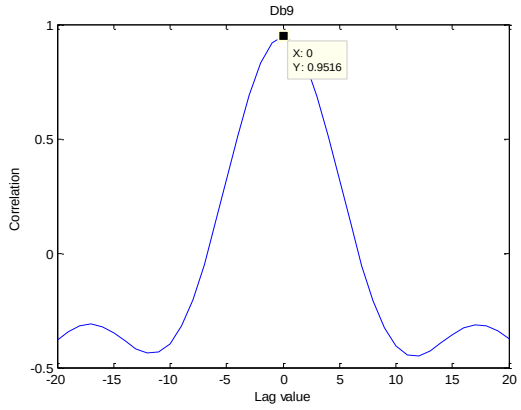

Figure 7: Daubechies Wavelet Audio Signal Correlation Graph

V. COMPARISON TABLE FOR AUDIO SIGNAL

COIF WAVELET	THRESHOLD VALUE	CORRELATION VALUE
COIF1	0.0340	0.9234
COIF2	0.0315	0.9427
COIF3	0.0292	0.9522
COIF4	0.0277	0.9543
COIF5	0.0280	0.9537

SYMLET WAVELET	THRESHOLD VALUE	CORRELATION VALUE
SYM1	0.0301	0.9091
SYM2	0.0344	0.9232
SYM3	0.0254	0.9494
SYM4	0.0239	0.9546
SYM5	0.0248	0.9550
SYM6	0.0262	0.9552
SYM7	0.0308	0.9476
SYM8	0.0286	0.9522

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SYM9	0.0329	0.9453
SYM10	0.0279	0.9539

DAUBECHIES WAVELET	THRESHOLD VALUE	CORRELATION VALUE
DB1	0.0301	0.9091
DB2	0.0344	0.9232
DB3	0.0254	0.9494
DB4	0.0255	0.9506
DB5	0.0360	0.9358
DB6	0.0309	0.9437
DB7	0.0275	0.9496
DB8	0.0330	0.9416
DB9	0.0265	0.9516
DB10	0.0320	0.9411

CONCLUSION

Three Wavelet families have been evaluated in case of audio signal: Symmlets order 1 to 10; Daubechies order 1 to 10 and Coiflet order 1 to 5. In the comparison of three Wavelets, namely, Coiflet Wavelet, Symlet Wavelet and Daubechies Wavelet, it has been found that the performance of Symlet Wavelet is the best, followed by Coiflet Wavelet and then Daubechies Wavelet. When we consider the case of Coiflet Wavelet, the value of threshold decreases for coif1 to coif4 and the value of the correlation between the original signal and the denoised signal goes on increasing. The correlation value is maximum in the case of Coiflet4 at lag0, followed by Coiflet5.When we observe the value for Symlet Wavelet, the pattern observed for threshold value in the case of Coiflet Wavelet is not found.

The maximum value of correlation is found at Symlet6, followed by Symlet5 and Symlet10. The maximum value of correlation in the case of Daubechies Wavelet is observed at db9. The difference in the correlation values is very minimal.Coiflet5, Coiflet4, Symlet5, Symlet6, Symlet10 and Db9 have been found to be the best for denoising purposes.

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