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Noise reduction from speech signal using MATLAB and Wavelet Transform

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Abstract:-**Speech is one of the most important signals in multimedia system. Speech enhancement is improving the quality of speech in real noisy environments for these multimedia systems. In this paper, Discrete-wavelet transform (DWT) based algorithm are used for speech signal de-noising. Analysis is done on noisy speech signal corrupted by F16 noise at 0dB, 5dB, 10dB and 20dB SNR levels. Simulation & results are performed in MATLAB 7.6.0.324 (R2008a). Thresholding methods used are soft and hard thresholding methods.**

Keywords:- **DWT, SNR, MATLAB**

1. INTRODUCTION

Speech de-noising is a field of engineering that studies methods used to recover an original speech from noisy signals corrupted by different types of noises. Noise may be in the form of white noise, pink noise, babble noise and many other types of noise present in the environment. Over the last decades, noise removal from speech signals is an area of interest of researchers during speech processing. Wavelet methods are mostly used for speech de-noising. The application areas of wavelet transform are 1D or 2D biomedical signal analysis, producing & analysing irregular signals or images, wavelet modulation in communication channels, in video coding and forecasting etc. The fundamental idea behind wavelets is to analyse according to scale. Wavelet transforms can decompose a signal into several scales that represent different frequency bands, and at each scale, the position of signal's instantaneous structures can be determined approximately. Such a property can be used for de-noising. Although without information on the signal to be analysed, wavelet select information by strongly reducing its quantity[1].

Other way, wavelet is a small wave and wavelet transforms convert a signal into a series of wavelets and provide a way for analysing waveforms, bounded in both frequency and duration. This allows signal to be stored more efficiently than by Fourier transform. Wavelet transform is preferred over Fourier Transform (FT) and Short Time Fourier Transform (STFT), since it provided multi-resolution. Recently, various wavelet based methods have been proposed for the purpose of speech de-noising. The wavelet split coefficient method is a speech de-noising procedure to remove noise by shrinking the wavelet coefficients in the wavelet domain. The method is based on thresholding in the signal that each wavelet coefficient of the signal is compared to a given threshold; if the coefficient is smaller than the threshold, then it is set to zero, otherwise it is kept or slightly reduced in amplitude. Soft and Hard Thresholding are used for de-noising the signals. Using wavelets to remove noise from a signal requires identifying which components contain the noise, and then reconstructing the signal without those components [3].

The principle under which the wavelet thresholding operates is to improve wavelet coefficients depends on a specific value, called threshold.

The de-noising algorithm is summarized as follow:
i) Compute the discrete wavelet transform for noisy signal.
ii) Based on an algorithm, called thresholding algorithm and a threshold value, shrink some detail wavelet coefficients.
iii) Compute the inverse discrete wavelet transform.

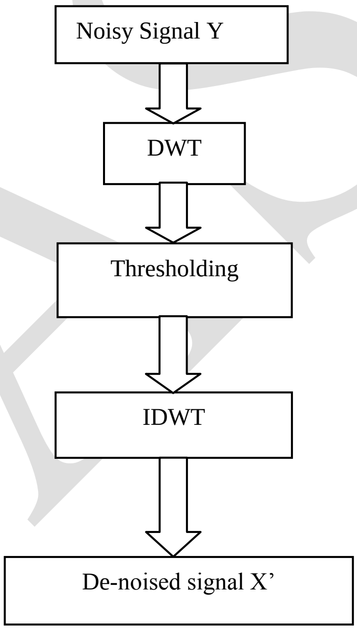

Figure 1 De-noising Algorithm [5]

2. THRESHOLDING ALGORITHMS

A. *Hard Thresholding*

$$\delta_\lambda^H(x) = \begin{cases} 0 & |x| \le \lambda \\ x & |x| \succ \lambda \end{cases}$$

Hard thresholding can be described as the usual process of setting to zero the elements whose absolute values are lower than the threshold[4]

B. *Soft Thresholding*

$$\delta_\lambda^S(x) = \begin{cases} 0 & |x| \le \lambda \\ sign(x)(|x| - t) & |x| \succ \lambda \end{cases}$$

Soft thresholding is an extension of hard thresholding, first setting to zero the elements whose absolute values are lower than the threshold, and then shrinking the nonzero coefficients towards 0.[4]

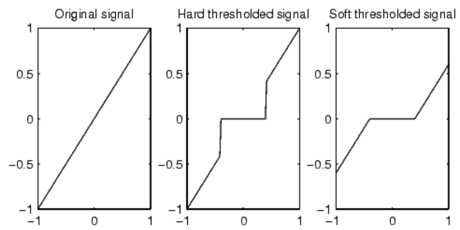

Figure 2 Comparison between soft and hard thresholding [4]

3. SIMULATION & RESULTS

A speech sample is taken corrupted with F16 noise in four SNR viz. 0dB, 5dB, 10dB, 20dB. These samples have been de-noised by soft and hard thresholding algorithms using Daubechies Db4 wavelet and DWT decomposition up-to level 5, on simulation software MATLAB v7.1.[2]

4. CONCLUSION

In this paper two types of wavelet based De-noising, hard threshold and soft threshold are applied for noise removal from speech signal. Noisy signal with F16 noise was prepared by adding F16 noise with clean signal using MATLAB v7.1 software at 20 dB, 10 dB, 0 dB and 5dB SNR levels. Hard thresholding is more suitable when noise level is higher because it discards the detail coefficient below threshold. Soft threshold based de-noising is more effective in present of low noise because here the coefficient are smoothened out.

REFERENCES

[1] C. Sidney Burrus, Ramesh A. Gopinath, and Haitao Guo, ”Introduction to wavelets and wavelet transforms: a primer” Prentice Hall 1998.

[2] ”Wavelet Toolbox-For use with MATLAB ” Mathworks Documentation.

[3] Robi Polikar “The Wavelet Tutorial” Rowan University College of Engineering.

[4] D. L. Donoho. “Denoising by Soft thresholding” *IEEE Trans on Information Theory*. 1995, vol. 41, no. 3, pp. 613-627.

[5] Saeed Ayat. “A New Method for Threshold Selection in Speech Enhancement by Wavelet Thresholding”, *International Conference on Computer Communication and Management,* 2011

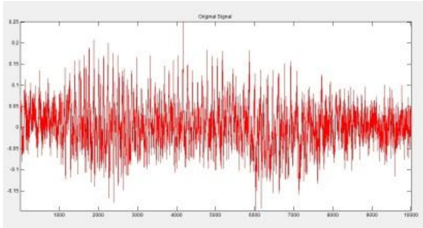

Figure 3 Noisy Speech Signal with SNR 0dB

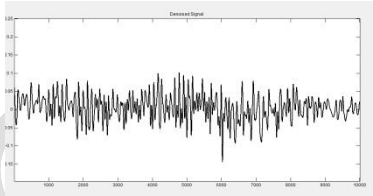

Figure 4 De-noised signal of Noisy Speech Signal with SNR 0dB using soft thresholding

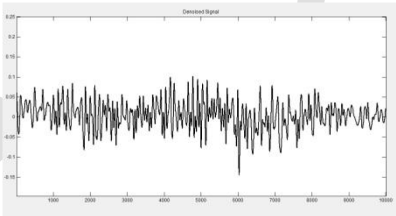

Figure 5 De-noised signal of Noisy Speech Signal with SNR 0dB using hard thresholding

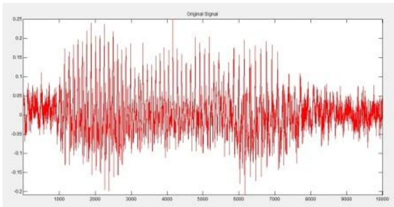

Figure 6 Noisy Speech Signal with SNR 5dB

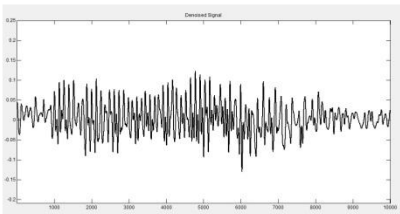

Figure 7 De-noised signal of Noisy Speech Signal with SNR 5dB using soft thresholding

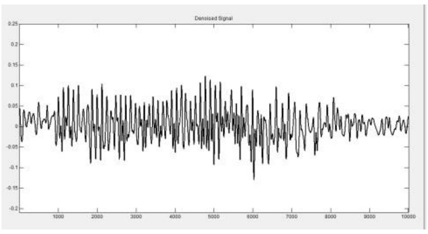

Figure 8 De-noised signal of Noisy Speech Signalwith SNR 5dB using hard thresholding

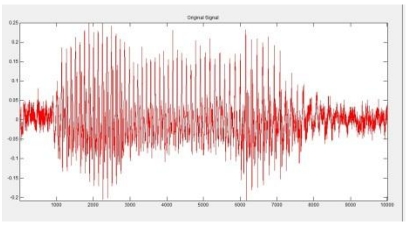

Figure 9 Noisy Speech Signal with SNR 10dB

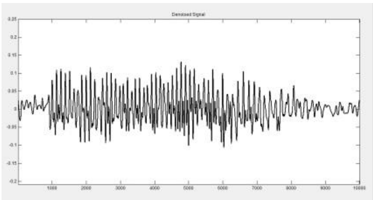

Figure 10 De-noised signal of Noisy Speech Signal with SNR 10 dB using soft thresholding

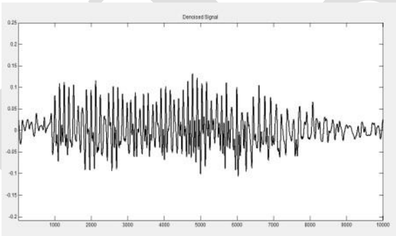

Figure 11 De-noised signal of Noisy Speech Signal with SNR 10 dB using hard thresholding

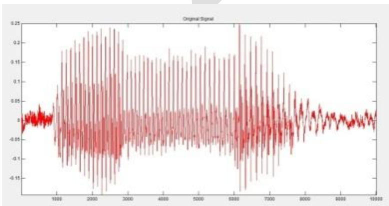

Figure 12 Noisy Speech Signal with SNR 20dB

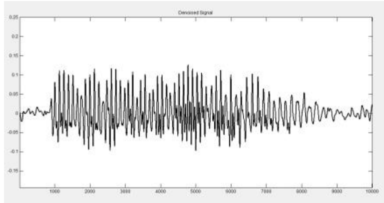

Figure 13 De-noised signal of Noisy Speech Signal with SNR 20dB using soft thresholding

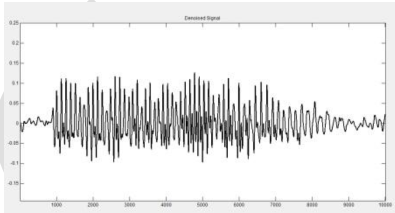

Figure 14 De-noised signal of Noisy Speech Signal with SNR 20dB using hard thresholding