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Speech Analysis in Praat Tool Using Hybrid Filter

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***Abstract*— Speech plays an important role in any communication system. An unwanted signal, known as noise, is added to speech and degrades the quality of signal. There are many speech enhancement techniques used for noise suppression such as spectral subtraction, wiener filtering, decision directed method etc. In this paper, we study some speech enhancement techniques, and proposed a hybrid filter using decision directed method and wiener filtering and then analyzed the intensity and pitch of noisy and enhanced speech in Praat tool, also compute the mean square error. Using hybrid filter, gets the better results and minimized the MSE of the signal.**

***Index Terms*— Speech Enhancement, Hybrid Filter, Praat Tool, MSE**

I. INTRODUCTION

Noise is an unwanted signal that degrades the quality of speech. Noise may be stationary and non stationary[1]. Speech enhancement plays an important role in any of the speech processing systems like speech recognition, mobile communication, and hearing aid. Many voice communication systems are designed for processing of noise free speech. However, speech signals used as an input to these systems are often degraded by some noise[2]. So the problem of enhancing speech degraded by additive noise, when only the noisy speech is present, has been widely addressed in the past few decades and it still provides an active field of research. Speech enhancement techniques can be classified into, single channel, dual channel or multi-channel enhancement. Although the performance of multi-channel speech enhancement is better than that of single channel enhancement3, the single channel speech enhancement is still a significant field of research interest because of its simple implementation and ease of computation[3]. There are many techniques used in speech enhancement. Spectral subtraction is one of the most widely used method because of its simplicity. Wiener filter gives better results than the spectral subtraction method in both stationary and non stationary signal. The well established decision-directed (DD) approach is computationally efficient and performs quite well in noise reduction applications, but during estimation it produces the frame delay. To overcome this problem we used a hybrid filter that is the combination of decision directed method and wiener filter.

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II. OVERVIEW OF SPEECH ENHANCEMENT TECHNIQUES

Speech Enhancement methods can be classified in many ways. A standard algorithm alone is insufficient for all the types of noise present in the surrounding. Therefore, speech enhancement algorithms are generated based on the applications[4].

[a] Spectral Subtraction Technique: This method is easy to implement and, for this reason, is widely used method. In this, estimated noise spectrum is subtracted from the noisy speech spectrum and obtained clean speech. It is applicable only for stationary signals[6].

[b] Wiener Filtering Technique : Wiener filter provides better results than the previous technique. It is the optimal filter and is better able to minimizes the mean square error.

[c] Decision Directed Method: The decision-directed method is performed to enhance a corrupted speech signal[5]. The decision-directed method is better able to reduce the effect of musical residual noise.

III. METHODOLOGY

For proposed work, 5 noisy speech signal were recorded at 4 kHz frequency with frame size 298. In which, 3 female voice, 1 male, and 1 child voice. Hamming window is used with 40% overlapping in 25ms frame length. These signals were then processed using hybrid filter. Using this, we compute SNR and MSE for enhanced signal and then praat tool is used to evaluate the performance of these speech signal. Praat is a freeware program for the analysis and reconstruction of speech signals. In this work praat tool is used for the analysis of spectrogram, pitch and intensity of noisy and enhanced signal. The results were obtained are shown in next section.

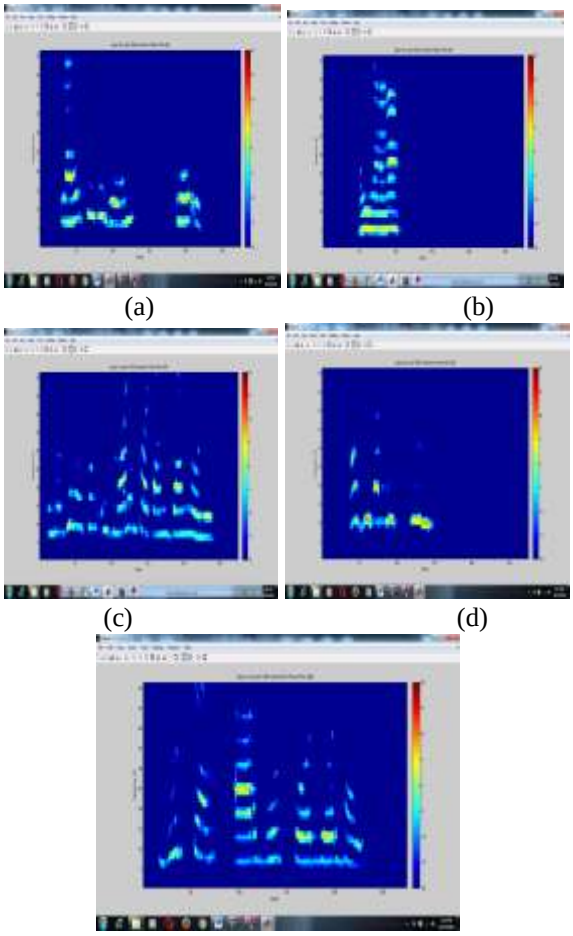
IV. RESULTS

In this, we recorded the 5 noisy speech signal at 4kHz sampling frequency with 16 number of bits. The enhanced signal is analyzed using praat tool. The input and output SNR is shown in Table 1.1

Table 1.1: Comparison of SNR value

Wave file	Input SNR of noisy signal	Output SNR of enhanced signal
a1	0.1323	0.1780
a2	0.1890	0.2437
a3	0.1416	0.1901
a4	0.1819	0.2332
a5	0.1623	0.2155

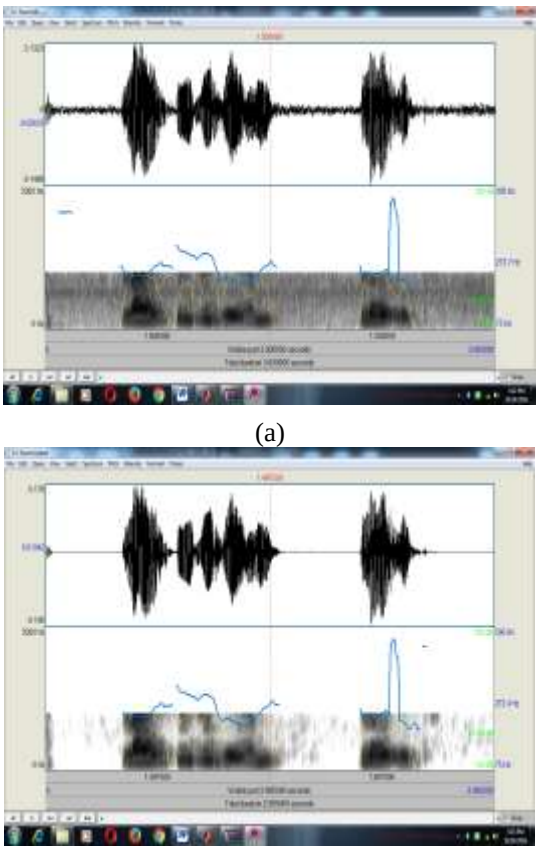
Spectrogram of the *a priori SNR* for these 5 signal is shown below:



(a) (b) (c) (d) (e)

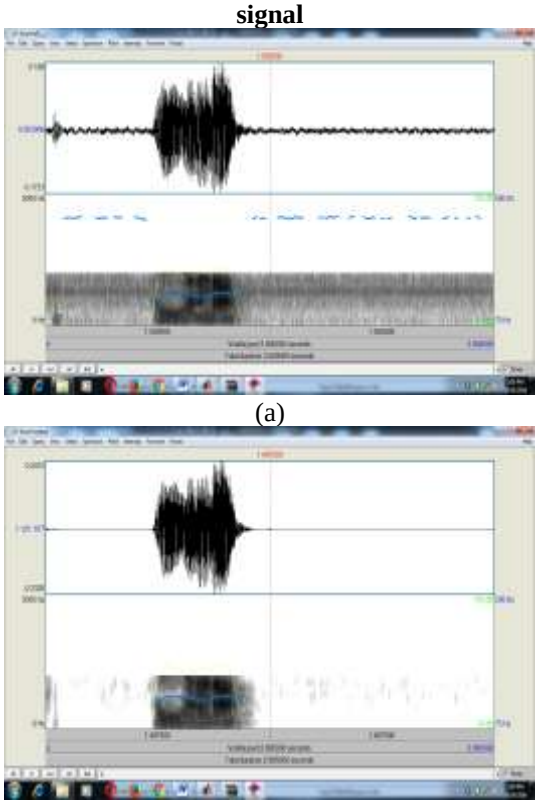
Figure 1.1 Spectrogram of Priori SNR estimation for noisy and enhanced signal

Using Praat tool, we analyzed the speech signal, spectrogram, pitch and intensity for noisy and enhanced signal. The waveform of speech noisy and enhanced signal using praat tool is shown in figure. These figure included the speech signal, spectrogram, pitch(in Hz), and intensity(in dB).



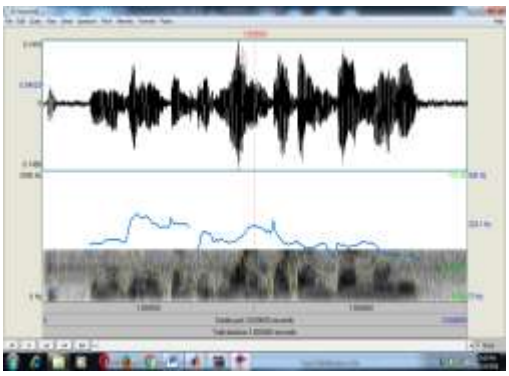
(a) (b)

Figure 1.2 Waveform of a1 noisy signal and enhanced signal

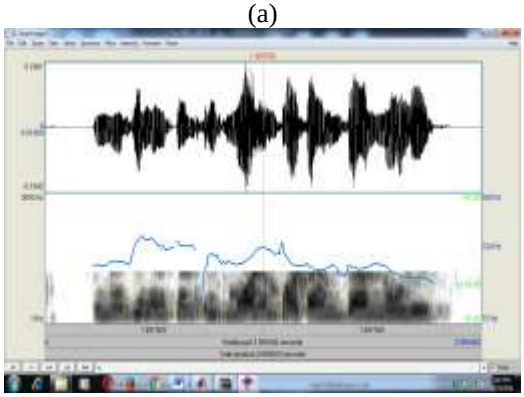


(a) (b)

Figure 1.3 Waveform of a2 noisy signal and enhanced signal



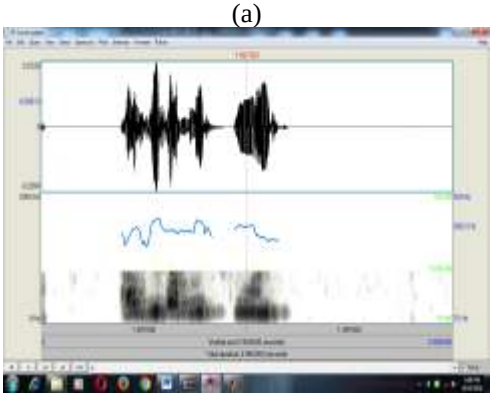
(a)



(b)

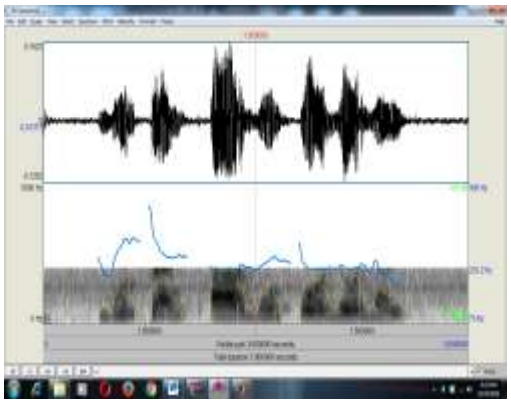
Figure 1.4 Waveform of a3 noisy signal and enhanced signal

(a)

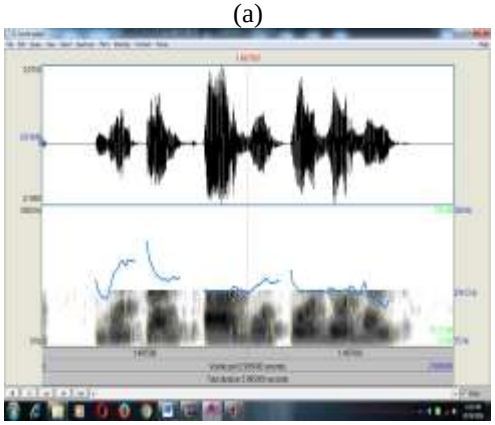


(b)

Figure 1.5 Waveform of a4 noisy signal and enhanced signal



(a)



(b)

Figure 1.6 Waveform of a5 noisy signal and enhanced signal

These waveform showed the signal waveform, spectrogram, blue lines indicate the pitch value in Hz and yellow line shows the intensity of the signal in dB.
Table 1.2 showed the maximum intensity value of noisy and enhanced signal which is determined by Praat tool. From table, it is clear that the intensity of enhanced signal is increased.

Table 1.2 : Intensity Of Noisy And Enhanced Signal

Wave File	Intensity of Noisy Signal(dB)	Intensity of enhanced signal(dB)
a1	70.92	73.39
a2	71.84	74.35
a3	70.16	72.71
a4	74.78	77.29
a5	70.69	73.20

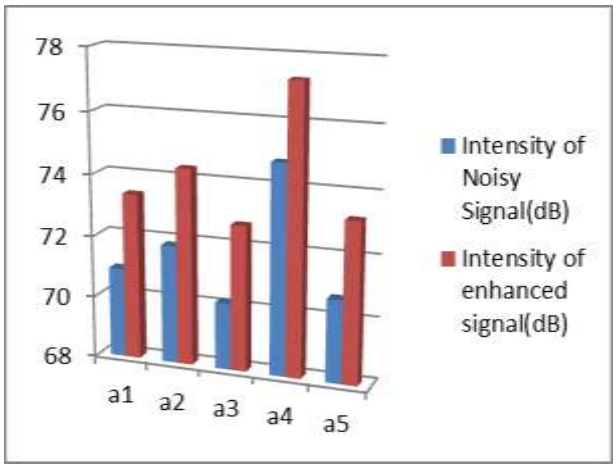


Figure 1.7 : Graphical Representation of Intensity

Table 1.3 showed the pitch value for noisy and enhanced signal measured using Praat tool. Pitch value is measured in Hz.

Table 1.3 :Pitch Value For Noisy And Enhanced Signal in Hz

Wave Files	Pitch of Noisy Signal in Hz	Pitch of Enhanced Signal in Hz
a1	476.10	465.89
a2	429.28	179.85
a3	361.01	360.51
a4	425.74	415.05
a5	429.46	390.11

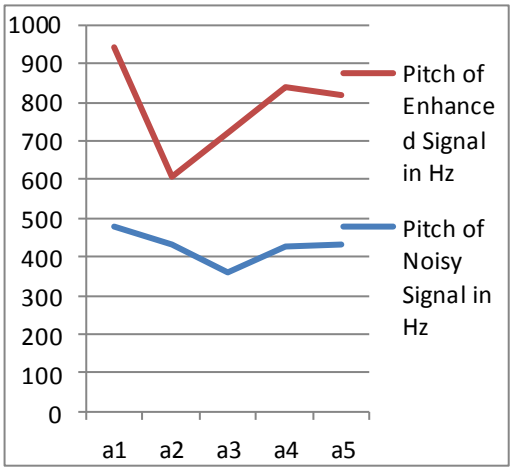


Figure 1.8 : Graphical Representation of Pitch of Noisy and Enhanced Signal

Table 1.4 shows the mean square error of noisy signal and enhanced signal. The figure 1.9(a) and 1.9(b) shows the graphical representation of mean square error of both signals.

Table 1.4: Mean Square Error of Wave files on 4kHz Sampling Frequency

Wave file	MSE of noisy signal	MSE of enhanced Signal
a1	7.2989e-04	5.3274e-07
a2	6.8482e-04	4.6897e-08
a3	7.5853e-04	5.7537e-07
a4	6.9635e-04	4.8490e-07
a5	6.6878e-04	4.4726e-07

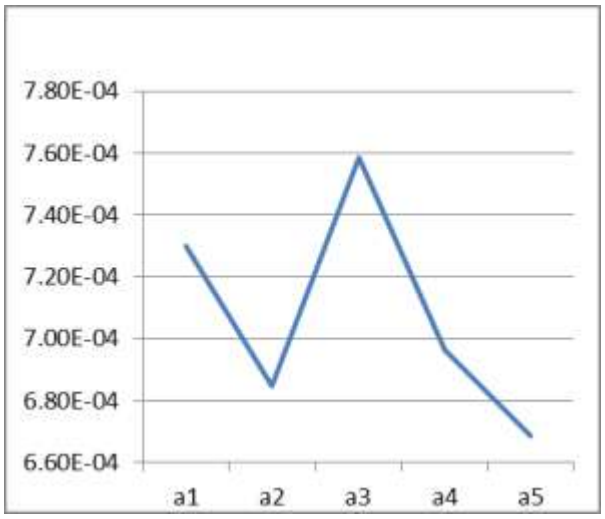


Figure 1.9(a) Graphical representation of MSE of noisy signal

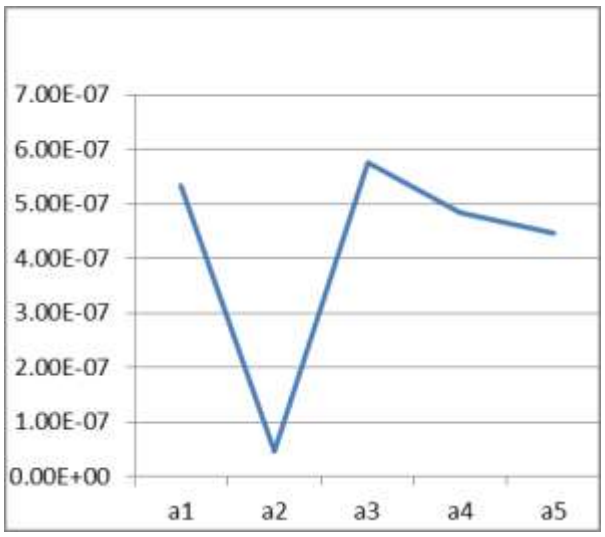


Figure 1.9(b) Graphical representation of MSE of enhanced signal

From the table it is concluded that MSE of enhanced signal is minimized as compared to noisy signal.

V. CONCLUSION

In this paper, we used the hybrid filter for enhancement of speech signal. This filter was applied to the 5 samples of recorded speech signal and compute SNR, and mean square eror. Then noisy and enhanced signal were analyzed using praat tool and estimate the pitch and intensity of speech signals. From the results, it can be seen that the hybrid filter is better able to reduce the noise, and mean square error and enhanced the signal.

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