Speech Enhancement by Spectral Subtraction Method

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ABSTRACT
Speech enhancement aims to improve speech quality and intelligibility by using various techniques and algorithms. Speech signal is always accompanied with some background noises. Speech processing and communication systems are to apply effective noise reduction techniques in order to extract the desired speech signal from its corrupted speech signal. That is, removal of background noise in the noisy speech. Some of noise reduction techniques are used in the speech processing like spectral subtraction, ceptral mean subtraction, blind equalization ,Adaptive wiener filtering ,Kalman filtering etc., are used various enhancement situations. Among this spectral subtraction is oldest one of the first algorithm proposed for removal of background noise. It is a single channel speech enhancement method for enhancement of speech degraded locale noise. The locale noise can disturb our conversation in a noisy environment like auditorium, street, market etc. This paper presents the performance of spectral subtraction algorithm is evaluate of a speech by signal to noise ratio value. Spectral subtraction algorithm is widely used in individual conversation due to its simplicity and implementation.

General Terms
Speech Enhancement, Filtering, VAD

Keywords
Spectral Subtraction, SNR, Noise Estimation

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1. INTRODUCTION
Speech is a natural and basic way for humans to convey message and thoughts. Speech frequency normally ranges between 3 Hz to 4 KHz depending upon the character. However the human beings have an audible frequency range of 20 Hz to 20 KHz. The most common problem in speech processing is the effect of meddling of noise in the speech signals. The noise masks the speech signal reduces the quality and the speech is greatly affected by presence of backdrop noise [3]. This make the listening task difficult for straight listeners and gives poor performance in some of speech processing like speech recognition ,speech coder and speaker identification etc.,[16]. Noise shrinking or speech enrichment algorithm is to improve the performance of communication systems when their input or output signals are corrupted by noise signal.

The main objective of speech enhancement is to improve one or more perceptual aspects of speech such as class or clearness [14].The quality is a subjective measure that indicates the naturalness of the perceived speech and intelligibility is expected by the percentage of words that can be correctly identified by listeners [6]. The performance measures the excellence and intelligibility is very tough to satisfy at the same time. This paper presents speech enhancement method using spectral subtraction algorithm with their performance evaluation.

This paper is organized as follows, Section II describe speech enhancement method, Section III represent spectral subtraction method, Section IV gives the details implementation and methodology ,Section V point up measures of performance ,Section VI shows the experimental results ,Section VII deals the conclusion.

2. SPEECH ENHANCEMENT METHODS
There are various speech enhancement methods proposed for noise reduction and to improve the speech quality and clearness. Only one algorithm is not enough for all the types of noise present in the surrounding. Hence speech enhancement algorithms are created based on the applications. The speech enhancement systems can be classified in different types. That is single channel speech enhancement, multichannel speech enhancement and model based speech enhancement etc [8]. The single channel speech enhancement is very less pricey and make easy to process. Multi channel assists to eliminate noise in an effective manner and it is high difficult to process.

Speech enhancement is categorized in to three different ways (i) Filtering techniques (ii) Spectral restoration (iii) Model based methods [4]. i.e., spectral subtraction, signal space approach, Signal to KLT method etc., Among these filtering techniques spectral subtraction method is oldest one and easy to estimate the noise. Too many spectral subtraction methods are normally used for enhancement purpose like magnitude spectral subtraction , power spectral subtraction , spectral subtraction with over subtraction , Berouti spectral subtraction ,multiband spectral subtraction etc.[5], are used various situation of noisy speech removal.

The block diagram of speech enhancement is show in figure.1 Speech noisy signal is segmented for 20-30ms samples taken and windowed.

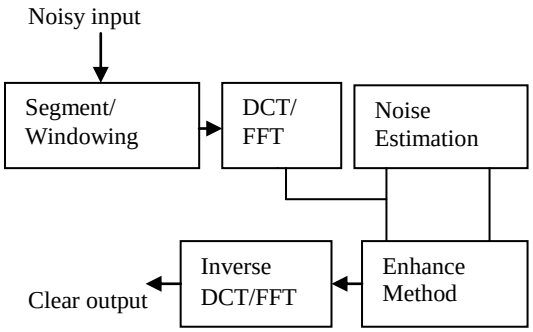

Fig.1.Block diagram of Speech Enhancement

Generally hamming window is used for speech is better. Then apply Fourier transform either Discrete or Fast Fourier transform of segmented and windowed. FFT is finest for speech enhancement. Noisy signal obtain and send to noise estimation block. This noise estimation block is used for calculate the overall noise in the original speech. Then if noise estimate is too low, unwanted residual noise will be audible else too high, speech will be unclear [11]. Enhancement block improve speech spectrum is generate and apply the inverse Fourier transform; it gives a clean speech signal.

3. SPECTRAL SUBTRACTION METHOD

Spectral subtraction is historically one of the oldest simple algorithm to implement easily and a minimal complexity of a speech enhacement. The spectral subtraction is based on the theory that the enhanced speech can be acquire by subtracting the estimated spectral factors from the continuum of the input noisy signal.

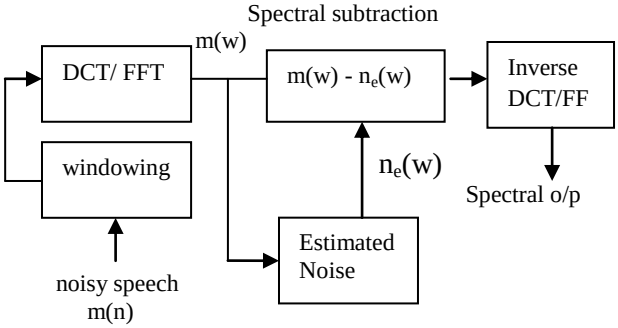

Fig.2.Block diagram of Spectral subtraction

Assuming n(s) is the noise signal, c(s) is clean speech signal and u(s) unclean noisy speech and it can be written as,

$$u(s) = c(s) + n(s) \text{ for } 0 \le s \le S-1 \quad (1)$$

Where s is the time index, S is a number of samples. Generally speech enhancement is calculate enhanced speech c(s) from given u(s) with the guess that n(s) is uncorrelated with c(s).Input signal u(s) is segmented into Z segments of the same time-span. The subsequent equation frequency domain is changed from time domain as,

$$Uz(w) = Cz(w) + Nz(w), \text{ for } 0 \le z \le Z-1 \quad (2)$$

Where Z is the segment key and U_z (w), C_z (w), N_z (w) are the Fourier magnitude taken from equation (1).If an estimate of noise continuum NN_z can be obtained ,then the speech CC_z can be get from U_z

$$CCz(w) = Uz(w) - \propto NNz(w) \quad (3)$$

In noise spectrum ,the none speech signal is estimated in the input signal . Voice activity detecter is used to find the quiet position in single channel speech enhancement. Here noise is imagine to be short ,so that noise from quiet frames can be used to remove noise from speech frames. The parameter α controls the amount of noise subtracted from the noisy signal. For full noise subtraction, α=1 and for over-subtraction α>1.

4. IMPLEMENTATION

Noisy speech signal which is degraded by noises at 10dB, 5dB, 0dB SNR is recorded in different environment. Sampling is carrying out at the rate of 16 ms and in each fragment it contains 128 samples. Hamming window is applied to the frame signal. The output frame chunk is given to DFT/FFT. After applying DFT/FFT, it calculates for the magnitude and phase for each frame. Then it verifies the entire clause and evaluates the noise estimation by using the method. Voice activity detector is utilize to ensure the voice or silence is present or not in the speech signal. After execute the entire operations next pace is to perform IDFT/IFFT to get back the new signal. Finally, realize the overlap and add method to the new signal to recover clear speech from noise speech.

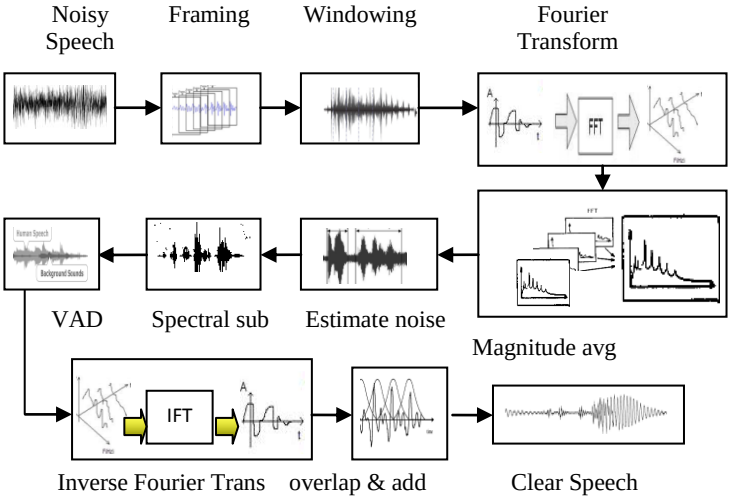

Fig.3.Flow diagram of Spectral Subtraction

5. MEASURES OF PERFORMANCE

5.1. Signal-to-Noise Ratio (SNR)

Signal-to-Noise Ratio (SNR)-to-noise ratio is a compute used in science and engineering that evaluates the level of a desired gesture to the level of background noise .Signal-to-noise ratio is sometimes used to refer to the part of useful information to extraneous data in a discussion or replace.

Signal-to- noise ratio is defined as the power percentage between a significant background noises. SNR Values in db.

$$SNR=10 \mathbf{X} \log_{10} \frac{\text{Mean (Input}^2\text{)}}{\text{Mean (Input}^2\text{-Enhanced}^2\text{)}}$$

6. EXPERIMENTAL RESULTS

The process of the spectral subtraction algorithm was verify in Matlab7.0 and gives a recorded input of a street noise of 0db, and 5db. The spectral subtraction algorithm gives enhanced results. The figure shows the input noisy speech of 0db and the spectral subtraction output of 0db.

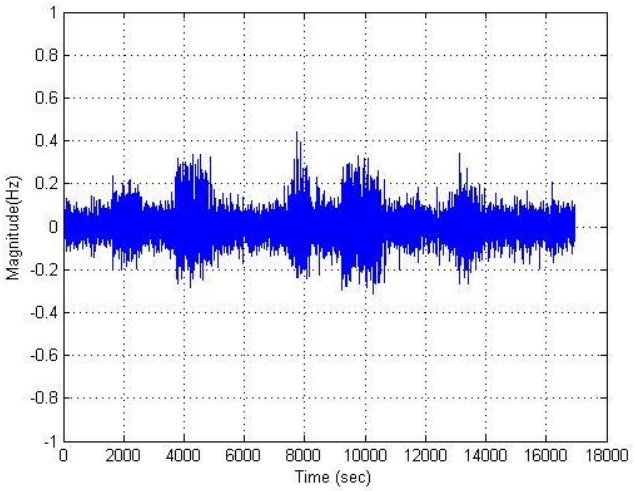

Fig.4. Original Speech of 0db

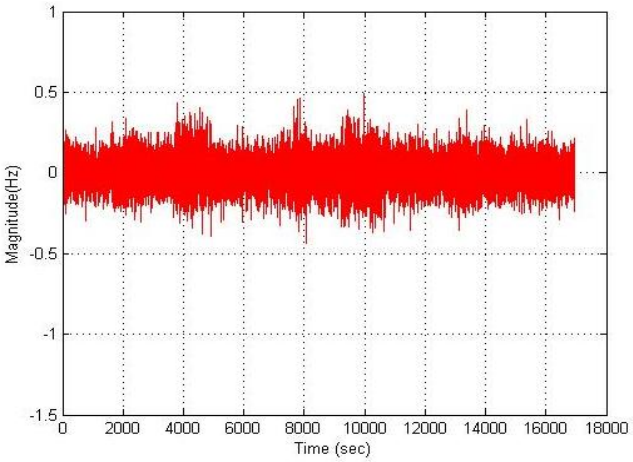

Fig.5.Noisy Speech of 0db

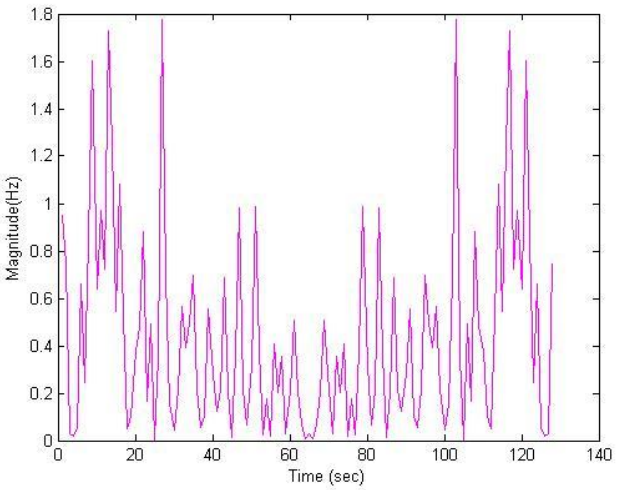

Fig.6. Magnitude Spectrum Speech of 0db

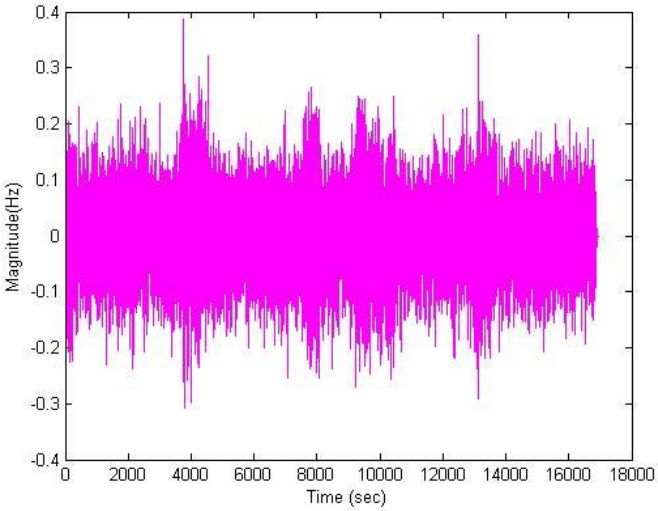

Fig.7. Spectral Filtered Speech output of 0db

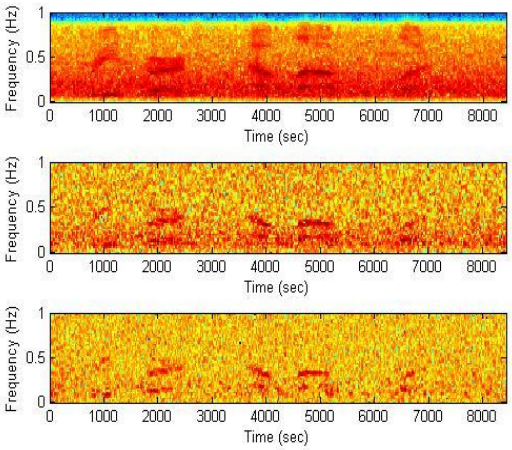

Fig.8. Spectrogram of filtered, noise, original of 0db

7. CONCLUSION

This paper deals the spectral subtraction method of noise removing. And this document achieved the outcome of spectral subtraction method of noise removal to the desired goal. Even though there are so many problems to reduce the noise in spectral subtraction method with effective manner. In future, Suitable filter may be implementing to attain high quality of clear speech from the blare situation. So further study of noise removal and comparison is very much needs to achieve satisfaction. The concert of the spectral subtraction method is appraised by using signal to noise ratio analysis which gives satisfactory results.

8. ACKNOWLEDGMENTS

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9. REFERENCES

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