NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT]
ISSN: 2394-3696
VOLUME 2, ISSUE 7, July-2015

A REVIEW OF LPC METHODS FOR ENHANCEMENT OF SPEECH SIGNALS

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Abstract

This paper presents a review of LPC methods for enhancement of speech signals. The purpose of all method of speech enhancement is to improve quality of speech signal by minimizing the background noise. This paper especially comments on Power Spectral Subtraction, Multiband Spectral Subtraction, Non-Linear Spectral Subtraction Method, MMSE Spectral Subtraction Method and Spectral Subtraction based on perceptual properties. As the spectral subtraction produces the Residual noise, Musical noise, Linear Predictive Analysis method is used to enhance the Speech.

Keywords: Power Spectral Subtraction, Multiband Spectral Subtraction, Non-Linear Spectral Subtraction Method, MMSE Spectral Subtraction Method and Spectral Subtraction based on perceptual properties

Introduction

Linear prediction coding methods needs highly efficient LPC filter and its excitation to provide high quality of speech at minimum cost. [1] In an abandoned surrounding the speech signals includes the noise, mixing of speech from other speakers and many other unwanted components. [2] This presence of noise reduces clarity and quality of signal. Removing or reducing such noise signal in order to improve the clarity of speech without losing its quality is really a challenge. [3]

Methods of Speech improvement are classified on the criteria such as number of input channels, time domain or frequency domain, adaptive or non adaptive and some additional constraints.

Various ways such as spectral subtraction method, subspace methods, Hidden Markov modeling, wavelet-based methods etc. were proposed for speech enhancement and further more improvements, revisions are done in proposed methods in order to achieve most efficient solution. The spectral subtraction method is widely used enhancement methods for all types of noise, has been chosen for its simplicity of implementation and low computational load [3]. Speech coding has been and still is a major issue in the area of digital speech processing. As a result, a greater emphasis is being placed on the design of new and efficient speech coder for voice communication and transmission. [4]

Literature Review

The several models proposed for minimization of noise present in the speech signal are having their own advantages and disadvantages; one has to analyze the methods and models depending upon the practical application where we are actually willing to utilize the models. Few models are discussed below in detail.

Power Spectral Subtraction Method:

Spectral subtraction is a method for restoration of the power spectrum or the magnitude spectrum of a signal observed in additive noise, through subtraction of an estimate of the average noise spectrum from the noisy signal spectrum. [5] This method is one of the oldest or firstly introduced methods for reducing the noise from the speech signal. The method proposed by Boll is very popular due to simplicity and high effectiveness in improving the speech due to noise addictiveness. The basic principle of this method is that one can approximate and renew the noise band when speech signal is not present and deduct it from the noisy speech signal to obtain clean speech signal spectrum. [6]The assumptions are to be made such that the noise signal is additive and noise is time invariant or slowly varying with time. The block diagram drawn below explains the method in better sense.

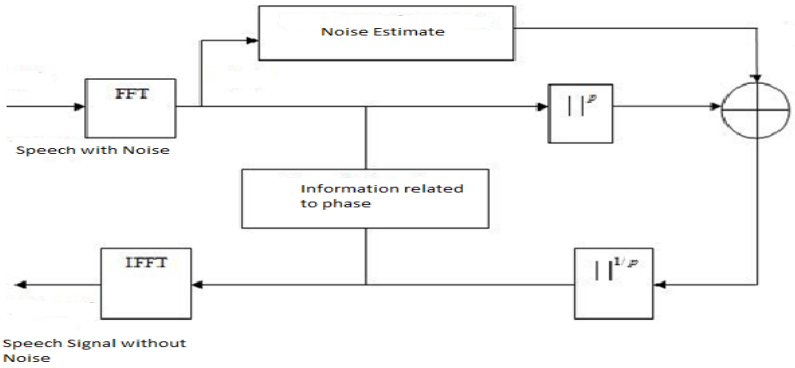

Figure 1: Block Diagram of Spectral Subtraction

In this method the noise signal is suppressed from the speech by subtraction of the approximate noise or estimated noise from the noisy speech signal. The noise band is estimated and modernized, for the duration of the periods when the signal is not present or when only noise is present. [7] These algorithms undertaking to be a universal way out for all types of noise surroundings. The limitation of this method is, the practical noise present in the surrounding is not constant and it is really challenging to suppress the noise present in speech.

Multiband Spectral Subtraction Method

This model also considered as one of the earliest proposed model for the suppression of noise.
Here the speech signal is divided in to x samples and subtraction of pre calculated sample noise signal is subtracted from each sample. [8]
There are four stages for execution of this method. In the first stage, the signal is windowed and FFT used to estimate the magnitude spectrum. In the second stage to calculate the over subtraction factor, we divide the noise and speech into different frequency band. The third stage includes processing the individual frequency bands by subtracting the corresponding noise spectrum from the noisy speech spectrum and in the last stage the modified frequency bands are recombined and the time signal is obtained by using the noisy phase information and taking the IFFT.

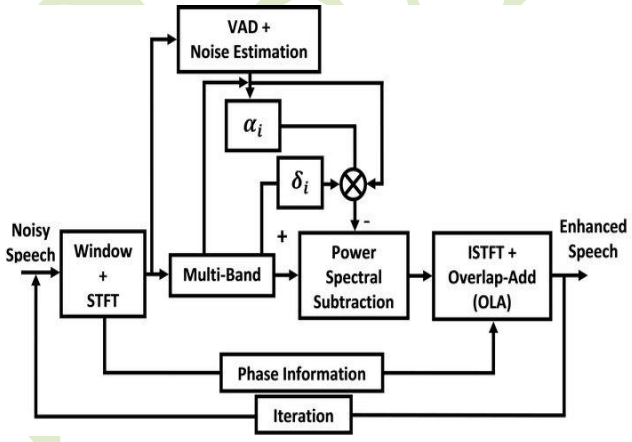

Figure2: Block Diagram of Multi-band Spectral Subtraction Method

Non-Linear Spectral Subtraction Method

The use of spectral subtraction in its basic form may cause deterioration in the quality and the information content of a signal. For example, in audio signal restoration, the musical noise can cause degradation in the perceived quality of the signal, and in speech recognition the basic spectral subtraction can result in deterioration of the recognition accuracy. In the literature, there are a number of variants of spectral subtraction that aim to provide consistent performance improvement across a range of SNRs. These methods differ in their approach to estimation of the noise spectrum, in their method of averaging the noisy signal spectrum, and in their post processing method for the removal of processing distortions. Non-linear spectral subtraction methods are heuristic methods that utilize estimates of the local SNR, and the observation that at a low SNR over subtraction can produce improved results. [5]

MMSE Spectral Subtraction Method

Minimum Mean Square Error (MMSE) Spectral subtraction method is proposed by Sim. [9] A method for selecting the subtractive parameters in the mean error sagacity. [10] In this method the mean square of the predefined error signal is subtracted from speech signal in order to improve the efficiency of the system by achieving a better quality speech signal.

Spectral Subtraction based on perceptual properties

In the previous methods, the subtractive parameters were computed experimentally, based on short term SNR levels [11] or obtained optimally in a mean square error sense [9]. No perceptual properties of the auditory system have been considered. An algorithm proposed by Virag [12] that incorporates psycho acoustical properties of speech signal, in the spectral subtraction process. The main objective of this algorithm is to remove the residual noise perceptually inaudible and improve the intelligibility of enhanced speech by taking into account the properties of the human auditory system [13]. Method proposed by Virag [12] was based on idea that, if the estimated masking threshold at a particular frequency is low, the residual noise level might be above. The threshold and will therefore be audible. The subtraction parameters should therefore attain their maximal values at that frequency. Similarly, if the masking threshold level is high at a certain frequency, the residual noise will be masked and will be inaudible. The subtraction parameters should attain their minimal values at that frequency.

Conclusion

This paper presents a review of LPC methods for enhancement of speech signals by minimizing the noise present in the speech. The purpose of all method of speech enhancement is to improve quality of speech signal by minimizing the background noise. This paper especially comments on Power Spectral Subtraction, Multiband Spectral Subtraction, Non-Linear Spectral Subtraction Method, MMSE Spectral Subtraction Method and Spectral Subtraction based on perceptual properties. All the methods discussed in this paper are having several advantages and disadvantages, moreover defining the method depending upon the application and utilizing it with full of its efficiency is big challenge.

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