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**Review Article**

# FILTERING OF NOISE IN AUDIO/VOICE SIGNAL-A REVIEW

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**A R T I C L E I N F O**

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**A B S T R A C T**

This paper represents a brief description of various types of filters used for the elimination of noise in audio/voice signal. The main objective of this survey paper is to find the better optimize filter which is used to provide the desire signal without any interference. Filtering is used in most digital signal processor applications to pass required frequency and stop unwanted frequency. There are many applications where digital filters are used such as voice/audio filtering, image processing and video processing and many more. In most applications filters are used to improve the performance of the desire signal. The idea of this paper is to analyze and compare the performance of IIR and FIR filters, and observe the signal free of interference.

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## INTRODUCTION

Digital communication is an essential part of our daily life routine. A voice is an amount produced by human being when it spoken with the use of vocal cords [1]. When voice is converted into electrical signals it becomes an audio signal. Voice frequency is within the part of audio range which is used for the transmission of speech. Frequency range of voice signal is from 300Hz to 3400Hz and frequency range of audio signal is 20Hz to 2000Hz. The standard cutoff frequency specified for low pass filter is 3400Hz, for high pass filter 600Hz and band pass filter range between 600Hz - 3400Hz [2][3].

During the processing of the signals some signals are mixed with the noise. For proper transmitting of the signal noise should be removed [4][5][6]. Use of filter removes noise or unwanted signals. Filters are designed in such a way that signal pass through the filter and remove unwanted signals. Filters are of two types' analog filter and digital filter. Input of analog filter is continuous in time whereas input in digital filter is discrete in time. Digital filters are further divided into two types categorized on the basis of impulse response as finite impulse response filter and infinite impulse response filter [7][8]. Finite impulse response is also known as non recursive filter whose impulse response of finite duration. Infinite impulse response digital filters are also known as recursive filter whose impulse response is of infinite duration.

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## LITERATURE REVIEW

Filters are designed in such a way that signal pass through the filter and remove unwanted signals. In most of the cases the signal is described in the form of frequency. For example, when a person will speak, it can be estimate the person speech in frequency range between 300Hz to 3400Hz. So filter is designed in such a way to pass the speech of the person. Digital filters use digital signal processor to remove unwanted signals. Digital filters are classified as finite impulse response and infinite impulse response filter [2][9]. Different types of FIR digital filters are used to eliminate the interference of noise from audio or voice signal. The cutoff frequency 3400Hz is taken as the limiting value of a low filter for audio or voice signal both in frequency and time domain. The cutoff frequency of low pass filter changes from 2600Hz to 4000Hz and good quality of voice changes nearby cut off frequency 3400Hz. The cut off frequency for high pass filter is considered 600Hz. The cutoff frequency of high pass filter varies from 300Hz to 1000Hz and good variation of voice quality is consider nearby cut off frequency of 600Hz. Hence the cut off frequency for band pass filter is between 600Hz to 3400Hz.

FIR filter uses different frequency windows such as rectangular window, triangular window, Kaiser Window, Chebyshev window, Blackman window, Hanning window, Gaussian window and Hamming window to find the frequency response of voice signal [10]. By analyzing different windows, there are no ripples which appear in pass band but there are smooth ripples in stop band. Almost same falling and rising curve have been seen above and below the cut off frequencies. For different windows of LPF the number of ripple changes from 26 - 29. For different windows of HPF, the number of

ripple changes from 1 - 4. For different windows of BPF, the number of ripples changes from 25 - 31. For different filters minimum number of ripple appears at Triangular window and maximum number of ripple appears at Kaiser Window.

type I and Chevyshev type II. Butterworth filter gives minimum noise as compare to Chevyshev type I and Chevyshev type II.

**Table number 1** Literature review

| Sr.No. | Name of author | Year | Technique | Remark |
|---|---|---|---|---|
| 1 | Pranab Kumar Dhar *et.al.* | IEEE 2008 | Different types of FIR digital filters are used for audio or voice signal. The standard cut off frequency specified in the literature for low pass filter is 3400Hz for high pass filter is 600Hz and for band pass filter it is 600Hz to 3400Hz [2]. | Effects of different types of FIR digital filtering for voice insignificant changes in voice quality and intensity were observed. |
| 2 | Pranab Kumar Dhar *et.al.* | IEEE 2008 | Analysis of different types of FIR filters for the frequency response of a voice signal on different frequency windows. On the basis of windows, minimum number of ripple appears at triangular window and maximum number of ripple appears at Kaiser window [10]. | The outputs of windows are analyzed on the basis of frequency response curve and hearing of sound. |
| 3 | Er. Krishan *et.al.* | IEEE 2012 | IIR digital filters are designed as Butterworth filter, Chevyshev type I, Chevyshev type II and Elliptic filter. Butterworth filter is the simplest among above four filters. As the cut off frequency increases the noise level decreases in the required signal. After particular range further increasing the cut off frequency the noise level start increasing in the required signal [11]. | Cut off frequency is not a value but it is a range which differentiates between pass band and stop band. |
| 4 | M. Bilal Shahid *et.al.* | IEEE 2015 | IIR digital filters are designed as Butterworth filter, Chevyshev type I and Chevyshev type II. By varying the order of filter from 10, 25, 40 and 55. Highest noise is observed in stop band with order of filter 55 and lowest noise in stop band with the order of 10 [12]. | Butterworth technique is the best technique as compare to Chevyshev type I and Chevyshev type II. |

Infinite impulse response digital filter require less memory, few design parameters and less complex as compare to FIR filter. IIR digital filters are designed as Butterworth filter, Chevyshev type I, Chevyshev type II and Elliptic filter. Butterworth filter is the simplest as compare to Chevyshev type I, Chevyshev type II and Elliptic filter. Butterworth filter has a maximally flat frequency response in pass band and stop band. For the design of Butterworth filter, some parameters like cut off frequency and order of filters varies to observe the noise variations, the order of the filter is fixed at 10 and changes the cut off frequency. For cut off frequency 10, the signal remains noisy up to certain values [11], as the cut off frequency increases the noise level decreases. As cut off frequency increases from 100, 1000, 1200, 1400 the noise level decreases in the required signal. Cut off frequency 1200 and 1400 is the range where level of noise is less in the signal. Further increase the cut off frequency 1500 and 2000 respectively, the noise level again increases in the required signal. Hence cut off frequency is not a value which differentiates between stop band and pass band but it is a range which differentiates between stop band and pass band. IIR digital filters like Butterworth filter, Chevyshev type I and Chevyshev type II filters are used for filtering of noise, by changing parameters like cut off frequency, order of filter and type of filter and keeping parameter constant like attenuation, sampling frequency and noise effect. By varying the order of the filter it is observe that at which order filter provides minimum noise. Consider sampling frequency, cut off frequency and attenuation constant and varying the order of filter from 10, 25, 40 and 55. Highest noise is analyzed in stop band with order of filter 55 and lowest noise in stop band with the order of 10 by using different orders of Butterworth filter [12]. For pass band noise is same for all the orders. For Chevyshev type I filter, as the order of filter increases it provide highest noise at cut off frequency but provide same noise in pass band and stop band. As compare to Butterworth filter, Chevyshev type I filter give higher noise at higher orders. For Chevyshev type II filter, it gives lower noise as compare to Chevyshev type I filter. As the order of the filter increased it gives higher noise at cut off frequency. Butterworth technique is the best technique among Chevyshev

After Butterworth filter, Chevyshev type II is better technique as compare to Chevyshev type I technique. As Chevyshev type II gives less noise as compare to Chevyshev type I.

## CONCLUSION

In this review paper, we have studied various types of IIR and FIR filter for voice signal and different ways to reduce the noise by using different types of filtering techniques. Using FIR filter we can decide the optimum value of cutoff frequency when voice signal were simulated through different filters. Frequency windows selected (such as rectangular window, triangular window, Kaiser Window, Chebyshev window, Blackman window, Hanning window, Gaussian window and Hamming window) to reduce the noise in desire signal. Study of IIR filters revealed cutoff frequency as an operating range instead of particular value. Different types of IIR filters as Butterworth filter, Chevyshev type I filter and Chevyshev type II filter were compared in reference to the noise signal. Butterworth filter as studied refer to the best type of filter among Chevyshev type I and Chevyshev type II for noise signal.

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