A Comparative Analysis of High- Pass FIR Digital Filter by using Rectangular Window and Bartlett Window Technique

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ABSTRACT

Digital filters are pervasive in the present era of communication systems. As a result good digital filter performance is important and hence to design a Digital Finite Impulse Response (FIR) filter satisfying all the required conditions is a demanding one. In this paper, design techniques of high pass FIR filters using Bartlett and Windows are proposed. The magnitude and phase responses are analyzed for different design techniques at particular cut off frequency and filter order. It is observed that degree of flatness varies with the length of the filter.

Keywords— DSP, Digital Filter, High-Pass, FIR, Rectangular Window and Bartlett Window.

1. INTRODUCTION

A digital filter is a mathematical algorithm implemented in hardware/software that operates on a digital input to produce a digital output [1] Digital filters differ from conventional analog filters by their use of finite precision to represent signals and coefficients and finite precision arithmetic to compute the filter response. The most straightforward way to implement a digital filter is by convolving the input signal with the digital filter's impulse response. All linear filters can be designed in this manner. Another way to design digital filters is recursion. When a filter is implemented by convolution, each sample in the output is calculated by weighting the samples in the input, and adding them together [2] A discrete-time filter produces a discrete-time output sequence $y(n)$ for the discrete-time input sequence $x(n)$. A filter may be required to have a given frequency response, or a specific response to an impulse, step, or ramp, or simulate an analog system [2]. Digital filters are classified either as finite duration unit pulse response (FIR) filters or infinite duration unit pulse response (IIR) filters, depending on the form of the unit pulse response of the system. In the FIR system, the impulse response is of finite duration, i.e. it has a finite number of non-zero terms. In other words, FIR filters are filters having a transfer function of a polynomial in z- and are an all-zero filter in the sense that the zeroes in the z-plane determine the frequency response magnitude characteristic [1][2].

Applications of DSP in area wise are as following:-

1).Telecommunication- Echo cancellation in telephone networks, equalization, telephone dialing application,, modems, line repeaters, channel multiplexing, data encryption, video conferencing, cellular phone and FAX.

2).Military- Radar signal processing, sonar signal processing, navigation, secure communications and missile guidance.

3).Consumer electronics- Digital Audio/TV electronic music synthesizer, educational toys, FM stereo application and soundrecording applications.

4).Image processing- Image representation, image compression, image enhancement, image restoration and image analysis

5).Speech processing- Speech analysis methods are used in automatic speech recognition, speaker verification and speaker identification.

6). Medicine- Medical diagnostic instrumentation such as computerized tomography (CT), X-ray scanning, Patient computerized tomography (CT), X-ray scanning,etc.

7).Signal filtering- Removing of unwanted background noise removal of interference, separation of frequency bands and shaping of the signal spectrum [3].

2. WINDOW TECHINIQUES

The desired frequency response of any digital filter is periodic in frequency and can be expanded in a fourier series, i.e.

$$H_d(e^{j\omega}) = \sum_{n=-\infty}^{\infty} h_d(n)\, e^{-j\omega} \text{ ……………………… } (1)$$

Where, **h(n)** $= \frac{1}{2\pi}\int_0^{2\pi} H(e^{j\omega})e^{j\omega}\, d\omega$

The Fourier coefficient of the series h(n) are identical to the The Fourier coefficient of the series h(n) are identical to the impulse response of a digital filter. There are two difficulties with the implementation of above equation for designing a digital filter. First, the impulse response is of infinite duration and second, the filter is non-causal and unrealizable. No finite amount of delay can make the impulse response realizable Hence the filter resulting from a Fourier series representation of $H(e^{j\omega})$ is an unrealizable IIR filter.

2.1 BARTLETT WINDOW FUNCTION

The window function of a non-causal Bartlett window is expressed by

$$W_{Bart}(n) = \begin{cases} 1+n, & -\frac{M-1}{2} < n < 1 \\ 1-n, & 1 < n < \frac{M-1}{2} \end{cases} \text{ ………… } (2)$$

2.2 RECTANGULAR WINDOW FUNCTION

The weighting function for the rectangular window is given by

$$WR(n) = \begin{cases} 1 \text{ for } |n| \le \frac{m-1}{2} \\ 0, \text{ otherwise} \end{cases} \text{ ……………………..(3)}$$

3. SIMULATION AND RESULT

Table 1: Parameter Specification

PARAMETER	VALUES
Sampling Frequency(Fs)	2000
Cut off Frequency(Fc)	500
Order(N)	10

Table2: Filter coefficients of Rectangular & Bartlett Window Techniques

Filter coefficient h(n)	Window Techniques	
	Rectengular	Burtlett
h(0)=h(10)	-0.0348808	0
h(1) =h(9)	0.0507787	0.0115892
h(2)= h(8)	0.0835080	0.0381180
h(3)= h(7)	-0.0546139	-0.0373935
h(4)= h(6)	-0.2914587	-0.2660783
h(5)	0.5220072	0.5956881

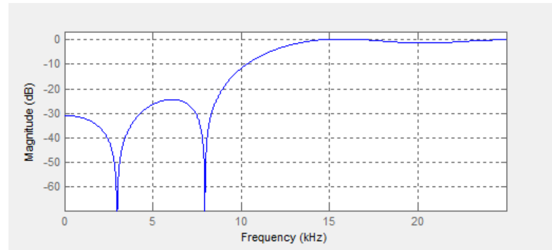

Fig.1: Magnitude Response of Rectangular Window Technique

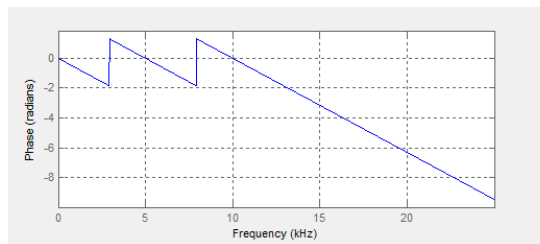

Fig.2: Phase Response of Rectangular Window Technique

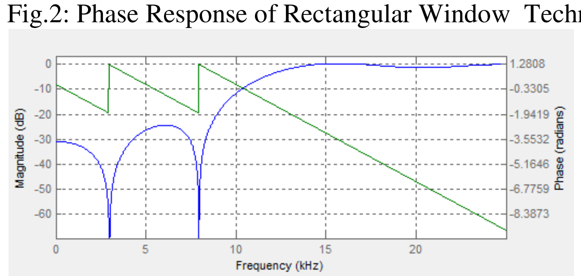

Fig.3: Phase Response & Magnitude Response of Rectangular Window Technique

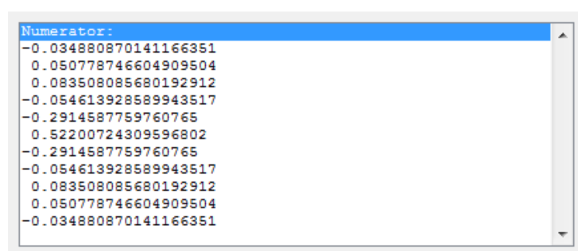

Fig.4: Filter coefficient of Rectangular Window Technique

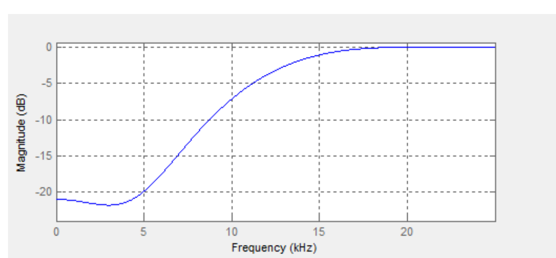

Fig.5:Magnitude Response of Bartlatt Window Technique

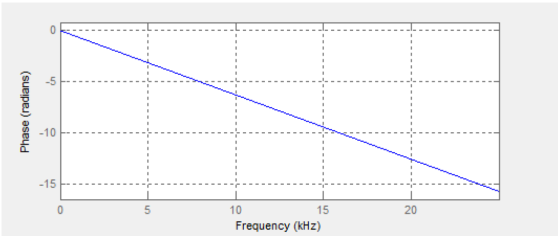

Fig.6:Phase Response of Bartlett Window Technique

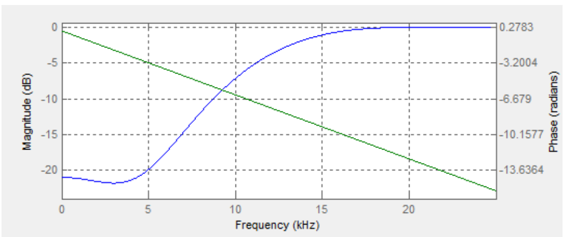

Fig.7: Phase Response & Magnitude Response of Bartlett Window Technique

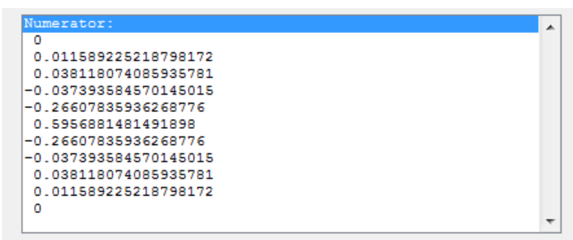

Fig.8: Filter coefficient of Bartlett Window Technique

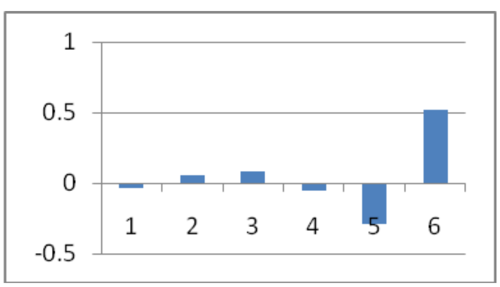

Fig.9: Magnitude and Frequency plot of Rectangular Window Technique

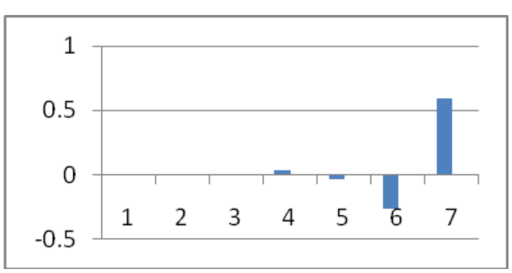

Fig.10: Magnitude and Frequency plot of Burtlett Window Technique

4. CONCLUSIONS

By analysis of performances of proposed FIR fill to we conclude that Rectangular Window Technique shows better response than Bartlett Window Technique.

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