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FIR Filter Design and Analysis Using Neural Network

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Abstract— This paper proposed to provide an alternative approach for comparison of FIR digital filter by using neural network. This proposed approach exhibit a relation between order and cutoff frequency of the filter having different order. In this paper using FDA tool to design digital FIR filters of different order, and neural network tool box to compare different filters. As the simulation results , the proposed neural-based method is capable of archiving a better performance for filter design.

Keywords— FDA tool, FIR filters, NN tool, Kaiser window, Hamming window, MATLAB.

1. INTRODUCTION

Digital filters are generally used for detachment of signals that have been combined, and reconstruction of signals that have been distorted in some manner. Digital filter design techniques are used to remove unwanted spectral content from the signal [1]. The input and output in the digital filter is in digital or discrete form. Generally, digital filters are linear time invariant (LTI) systems which are distinguish by unit sample response with minimum interference and other effects [2]-[3]. FIR Digital filters can extract signal components from a signal that contains different signal components concentrated at different frequencies [4]. The Filter Design and Analysis Tool (FDA Tool) is mainly used to represent graphical user interface for designing and analyzing filters quickly. FDA Tool allows you to design digital FIR filters by adjusting filter specifications [4]-[5], by importing filters from MATLAB.

2. METHODOLOGY

In this paper we are designing a high pass FIR filter using different orders and window techniques with the help of FDA tool in MATLAB. The window techniques used are Hamming, Kaiser and Blackman [6]. Imported data from FDA tool is to train on the Artificial Neural Network by using feed forward back propagation algorithm. In this research the result of different order filter which shows that main width lobe decrease and decreasing the cutoff frequency as order increases [7] which is shown in table 1.Data shown in table 1 is implemented on NN tool. In this paper different order of filter are selected and other parameters are considered as:

Sampling frequency- 1000 HZ
Pass band frequency-160 HZ
Stop band frequency-260 HZ
Pass band ripple- 1db
Stop band ripple-40db

The Cutoff frequency can be calculated by using formula

$$\omega_c = \frac{\omega_p + \omega_s}{2} \quad (1)$$

3. DIGITAL FIR FILTER

FIR filters are those digital filters which are having impulse response of finite duration, because in this signal settles to zero in finite duration. In particular to convert an "ideal" impulse response of finite duration, such as a sine function to a finite impulse response filter design, that is called the window method [8]. The ideal high pass filter is one that permits through all frequency components of a

signal above a designated cutoff frequency and rejects all frequency components of a signal below. The FIR filter also known as non recursive digital filter as they do not have the feed-back even though recursive algorithm can be used for FIR filter realization [9].

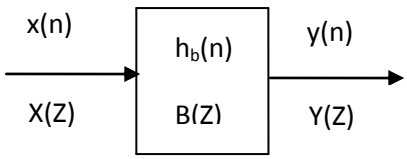

Fig 1 FIR Filter

Algorithm:

$$b(n) = \omega(n).h(n), \quad 1 \leq n < N \qquad (2)$$

Where h(n) is the impulse response of ideal filter and ω(n) is the window function.

A. HAMMING WINDOW

We analyze the filter using Hamming window technique by using FDA tool in MATLAB and the frequency response of the filter is given in figure 2 respectively with order 10, 30, 50 & 70 [10].

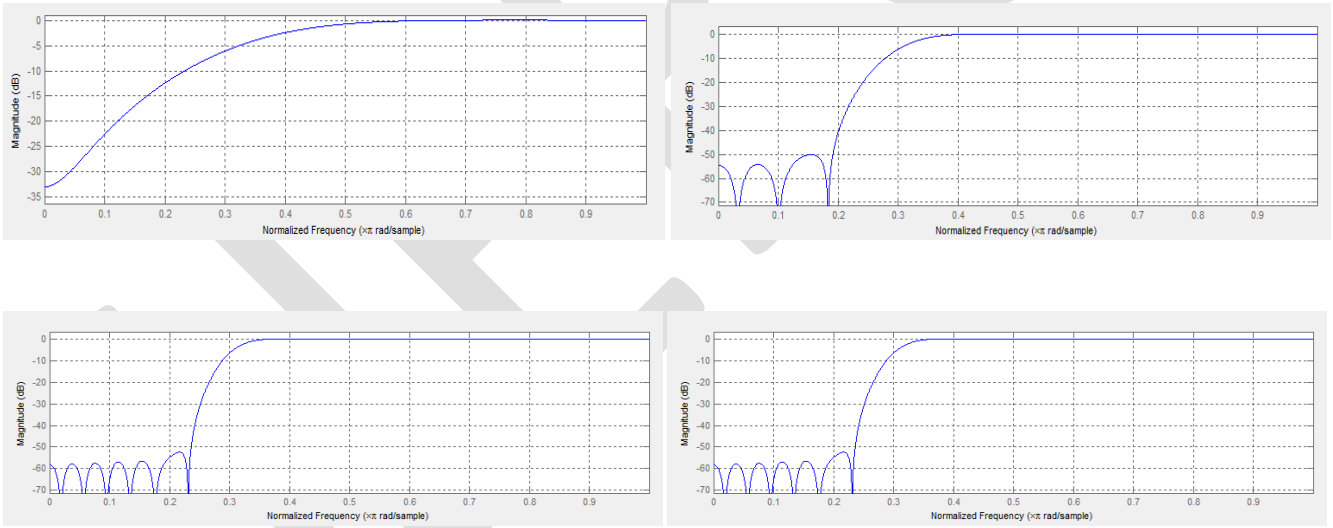

Fig 2 .Hamming Window Filter with Order 10, 30, 50 and 70.

B. KAISER WINDOW

We analyze the filter using adaptive window or Kaiser window technique by FDA tool in MATLAB and the frequency response of the filter is given in figure 3 respectively with order 10, 30, 50 and 70 [11].

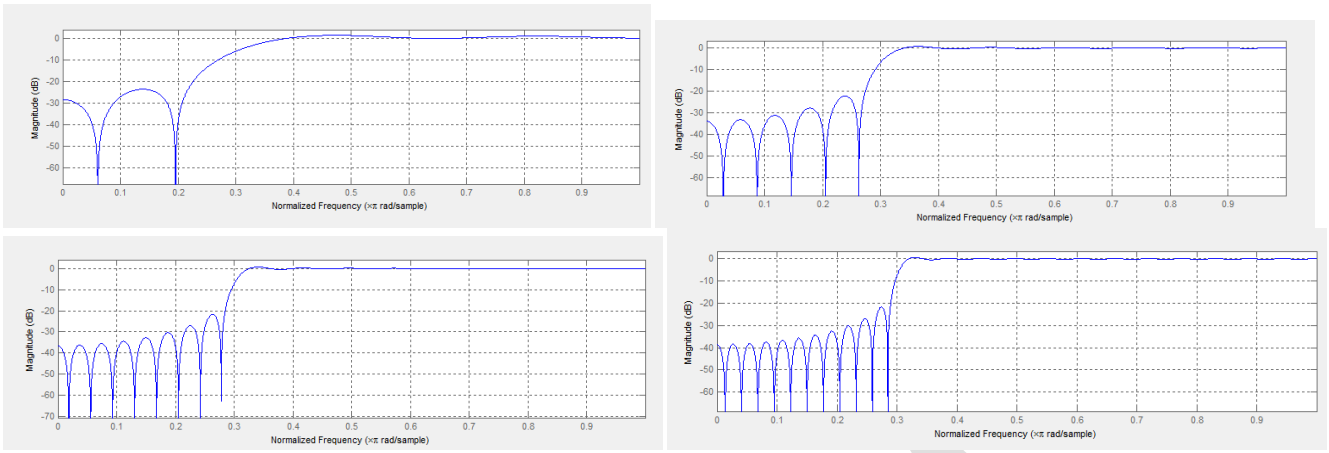

Fig 3 Kaiser Window Filter with Order 10, 30, 50 and 70

C. BLACKMAN WINDOW

We analysis the filter using Blackmann window By FDA tool in the MATLAB and the response of the filter is given in figure 4 respectively at the order 10, 30, 50 and 70. [12]

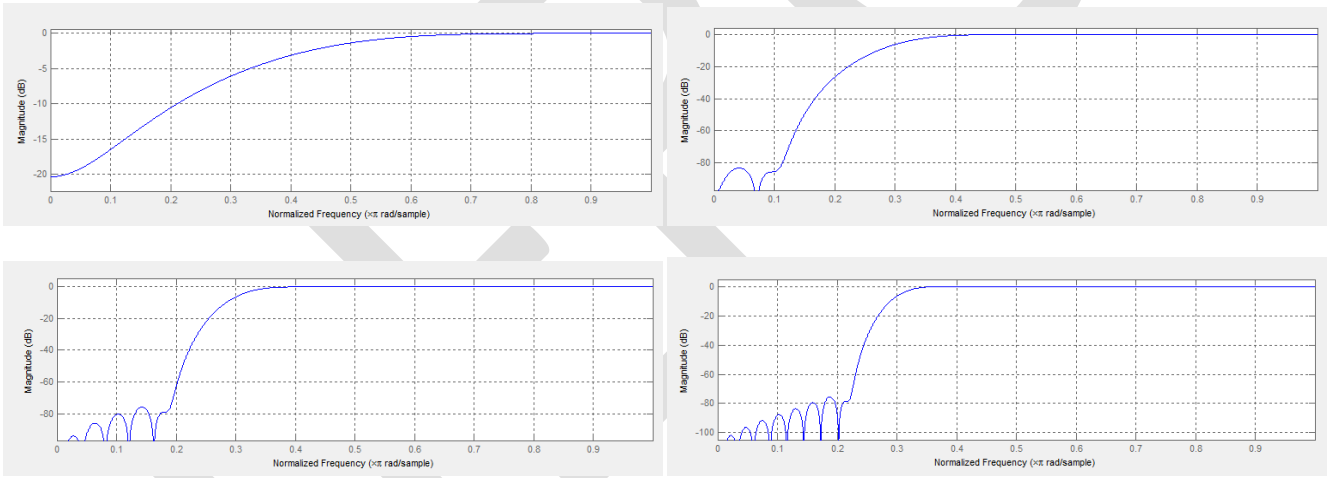

Fig 4 Blackman Window Filter with Order 10, 30, 50 and 70.

4. NEURAL NETWORK

The fig obtained with the help of neural network is shown below. The Figure 5 shows the best validation performance for cutoff frequency and different order of High pass FIR filter.

Table 1(a)

(Comparison of different FIRfilter)

s.no	order	Cutoff freq(Hz)	Main width lobe (db)	No of side lobe
1	10	0.3353	66.26637	2
2	20	0.3260	61.36727	3
3	30	0.3166	59.7629	5
4	40	0.3127	57.3919	6
5	50	0.3100	53.21346	8
6	60	0.3090	67.36309	9
7	70	0.3081	54.8122	11

(a) Kaiser window cutoff frequency with order 10-70

Table 1(b)

s.no	order	Cutoff freq.	Main lobe width	No of side lobe
1	10	0.3985	19.8635	0
2	20	0.3507	66.2323	0
3	30	0.3342	96.9096	1
4	40	0.3278	86.7607	3
5	50	0.3225	95.6394	4
6	60	0.3194	94.7614	6
7	70	0.3178	104.547	7

(b) Blackman window cutoff frequency with order 10-70

Table 1(c)

s.no	order	Cutoff freq	Main width lobe	Side lobes
1	10	0.3791	32.70531	0
2	20	0.3437	70.9076	1
3	30	0.3288	69.23793	3
4	40	0.3218	70.4234	4
5	50	0.3187	69.9837	6
6	60	0.3149	69.5544	7
7	70	0.3140	73.3426	9

(c) Hamming window cutoff frequency with order 10-70

Table 2
(Best validation based on order and cutoff frequency)

Window technique	Best validation
Hamming window	1.9699e-05
Blackman window	0.00086549
Kaiser window	1.3105e-05

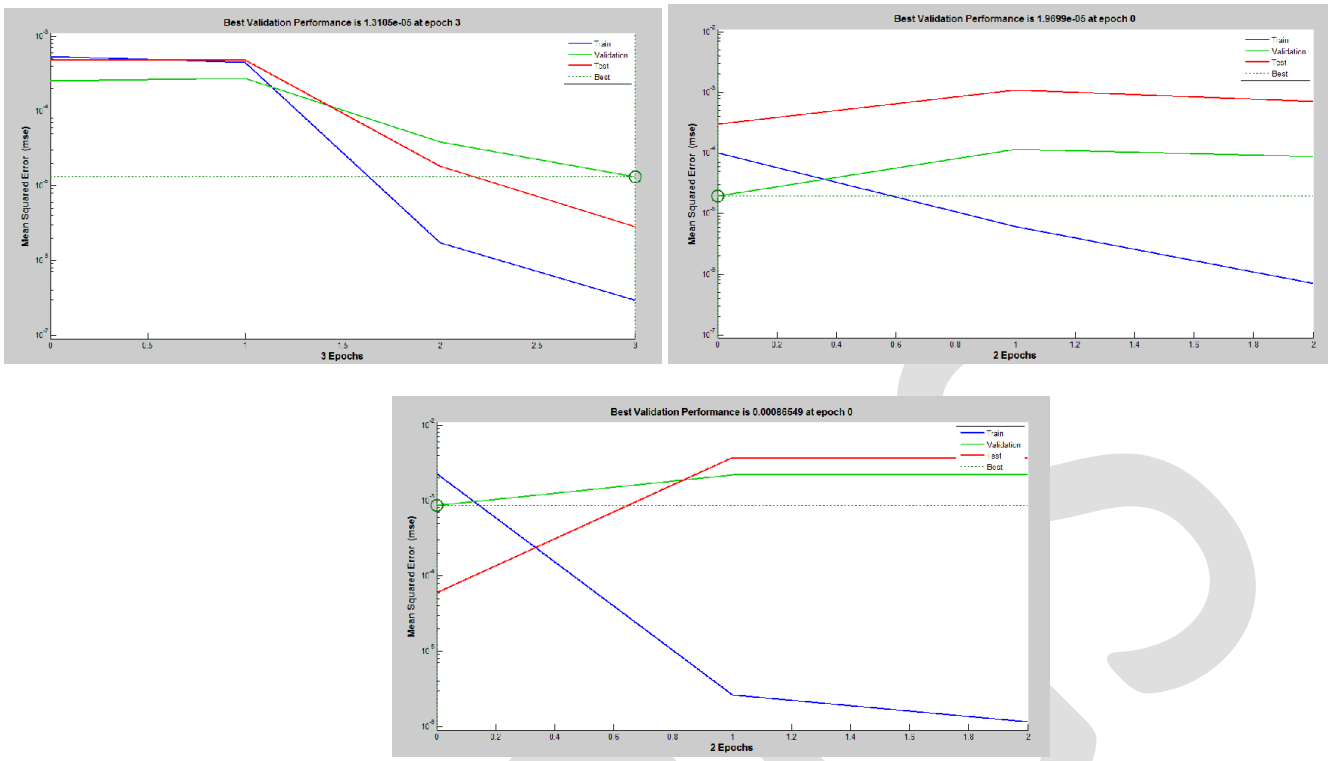

Fig 5 Best validation performance of Kaiser, Hamming and Blackman Window Filter respectively, based on cutoff frequency.

5. CONCLUSION

In this paper comparative study of different digital filters and evaluation of best validation point with the help of Artificial Neural Network (NN) tool has been done. This paper shows BlackmanFilter based on order and cutoff frequency having best validation performance among other three filters. Results shows side lobe increases with respect to increase in order of digital filters which enhance the loss of information.Blackman window shows better performance as compared to other three window techniques.

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