Comparison of FIR Filters Using Neural Network and FDA tool

PRAVEEN SHARMA, R .P.NARWARIA

Department of Electronics, Madhav Institute of Technology and Science Gwalior, India

ABSTRACT

This paper intended to provide an alternative approach for comparison of FIR digital filter by using neural network. This proposed approach establishes relation between (I) order and main width lobe of filter and (II) order and cutoff frequency of filter. 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 shows, the proposed neural-based method is capable of archiving a better performance for filter design.

KEYWORDS - FDA tool, FIR filters, low pass filter, nntool.

1 INTRODUCTION

Digital filter design techniques are widely used in different areas. The digital filters consist of software and hardware. The input and output signals in the digital filter is digital or discrete time sequence. Basically, digital filters are linear time invariant (LTI) systems which are characterized by unit sample response these filters are highly flexible and portable and it has minimum/negligible interference noise and other effects. Digital filters are easier in storage, maintenance and reduced failure time. The design of finite impulse response (FIR) digital filter has received a great deal of interest over the past two decades. The Filter Design and Analysis Tool (FDA Tool) is the powerful user interface for designing and analyzing filters quickly [1]. FDA Tool permits you to design digital FIR or IIR filters by setting filter definition [3]-[5], by importing filters from MATLAB.

2 Methodology

In this paper using different type of window techniques and different type of order with the help of FDA tool in MTLAB software, design low pass FIR filter based on Kaiser, Hamming and Blackman window technique[8][9]. Collected data from FDA tool train on the Artificial Neural Network using feed forward back propagation algorithm. In this research performance of different order filter which shows that as order increase main width lobe decrease and increasing the cutoff frequency [1][2] which is shown in table1. Data shown in table 1 train with ANN tool. In this paper different order of filter selected and other parameter is given as.

Sampling frequency- 800 HZ
Pass band frequency-175 HZ
Stop band frequency-250 HZ
Pass band ripple- 1db
Stop band ripple-40db

The Cutoff frequency calculated using formula

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

3 Digital FIR Filter

FIR filters are digital filters with finite impulse response. In particular to convert an "ideal" impulse response of infinite duration, such as a sin function to a finite impulse response filter design, that is called the window method [11]. The ideal low pass filter is one that permits through all frequency components of a signal below a designated cutoff frequency and rejects all frequency components of a signal above. 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[13][14].

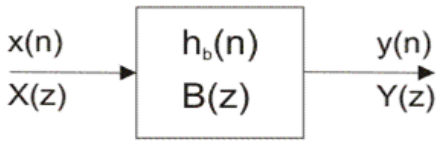


Fig 1 FIR Filter

Algorithm:

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

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

3.1 Hamming Window

We analysis the filter using Hamming window or fixed widow by FDA tool in the MATLAB and the response of the filter is given in figure2 respectively at the order 10, 20& 30[10].

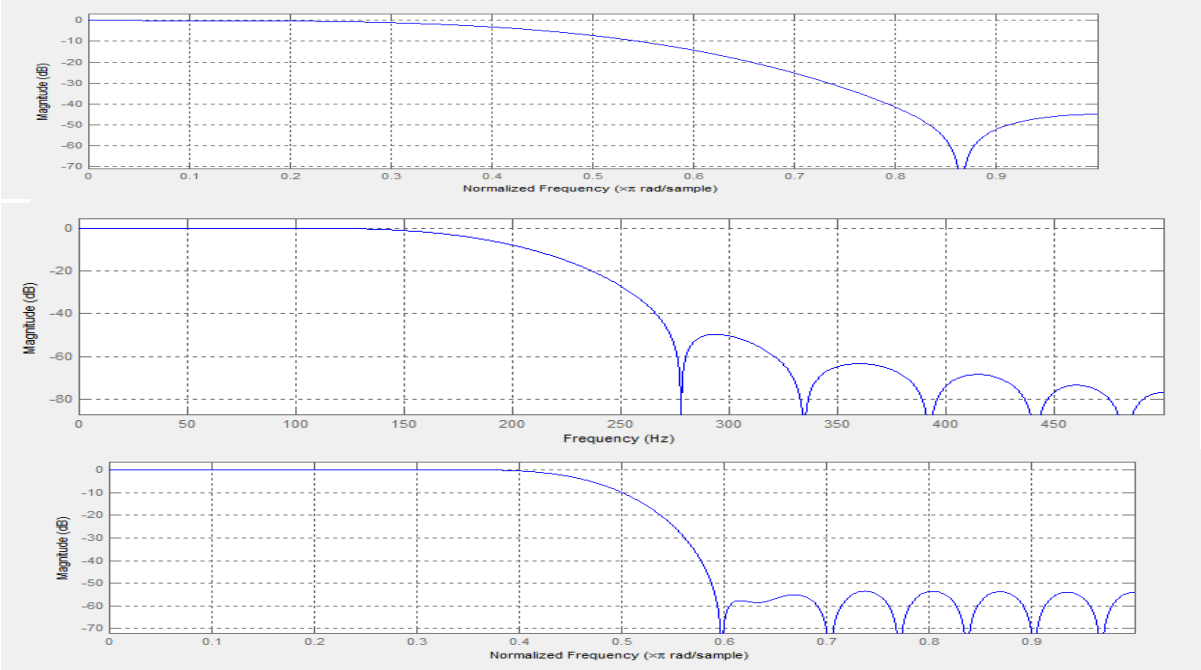


Fig 2. Hamming Window Filter with Order 10, 20 and 30.

3.2 Kaiser Window

We analysis the filter using adaptive window or Kaiser window By FDA tool in the MATLAB and the response of the filter is given in figure 3 respectively at the order 10,20 and 30.[8][9].

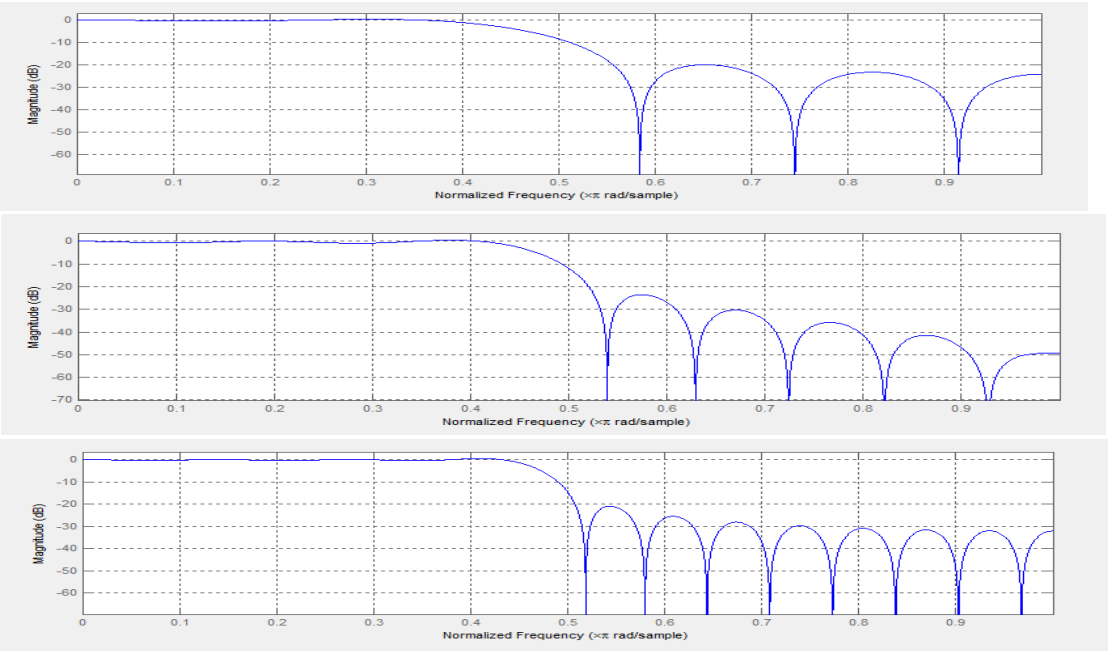
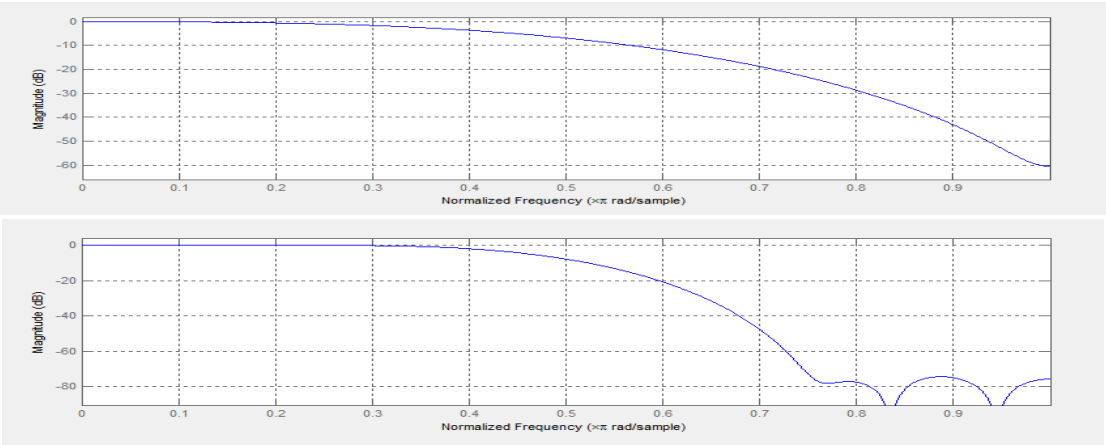


Fig 3 Kaiser Window Filter with Order 10, 20 and 30.

3.3 Blackman

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, 20 and 30. [10]



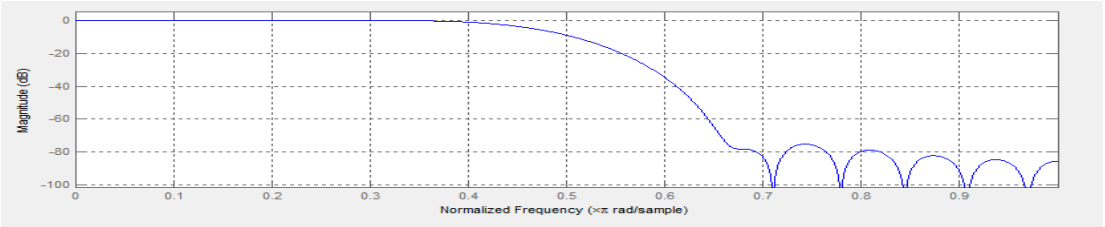


Fig 4 Blackman Window Filter with Order 10, 20 and 30.

4 Neural Network

The plot obtained by the help of the neural network is shown below. The Figure 5 shows the best validation performance is 0.057088 for main width lobe and 0.00091166 for cut off frequency for low pass FIR filter 2.

Table 1

(Comparison of different FIR filter)

Filter	order	Width of main lobe(db)	No of side lobe	Cut of frequency(HZ)
Hamming window	10	0.847	1	0.398
	20	0.650	4	0.4375
	30	0.593	6	0.451
Blackman window	10	0.9294	0	0.38
	20	0.8281	2	0.42
	30	0.7088	5	0.44
Kaiser window	10	0.5837	3	0.28
	20	0.538	5	0.45
	30	0.516	8	0.46

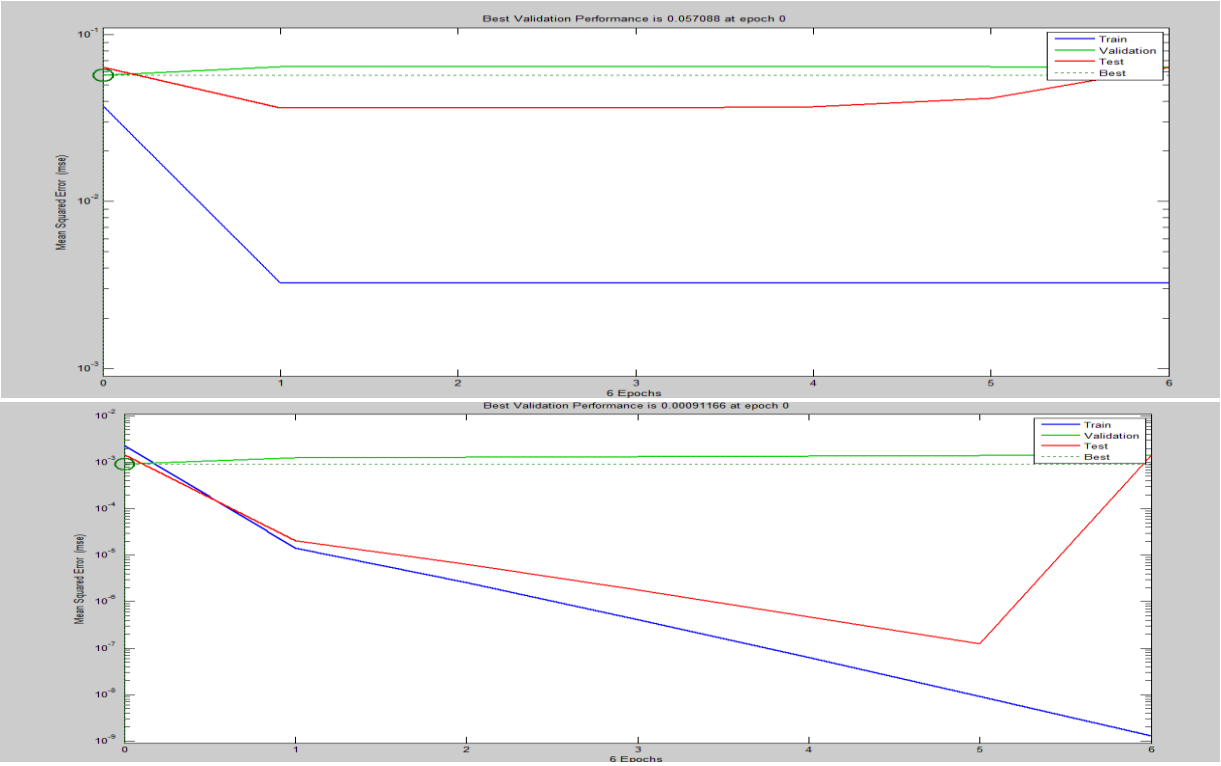


Fig 5 Best validation performance of Hamming Window Filter based on main width lobe and cutoff frequency.

Table 2

Table 2.1 (Best validation based on order and cutoff frequency)

Window technique	Best validation
Hamming window	0.0009166
Blackman window	7.938e-0.05
Kaiser window	6.7439e-0.22

Table 2.2 (Best validation based on order and main width lobe)

Window technique	Best validation
Hamming window	0.057088
Blackman window	0.043061
Kaiser window	0.00019809

5 Conclusion

In this paper comparison of Different window filters and calculate best validation which shown in table 2 with the help of ANN tool. After training with Neural Network results shows that Best validation performance of Hamming Window Filter based on main width -lobe and cutoff frequency among three filters. Table (1) shows that as order increase side lobe also increase but increasing of side lobe is not good because increasing of side lobe wastes of information so less number of

side lobes is good. In comparison of all three window side lobe in blackmann window filter is less. Which means loss of information is less that shows in table (1)[12].

References

1] Design and Analysis of Low Pass FIR & IIR Filter and Find Optimum Result Using Neural Network [Global Journal of Researches in Engineering].

[2] Sara Moein, "FIR Cutoff Frequency Calculating for ECG Signal Noise Removing Using Artificial Neural Network" Verlag Berlin Heidelberg,pp.124-131(2010).

[3] Sanjit K. Mitra, "Digital Signal Processing: AComputer-Based Approach", Second Edition, McGrawHillScience/Engineering/Math,2001,pp.446-472.

[4] S.Salivahanan,"DigitalSignal Processing",McGraw-Hill, 2000, pp. 735-749.

[5] B. A. Shenoi, "Introduction to SignalProcessing and Filter Design", Wiley Interscience, 2006,pp-273-285.

[6] Andreas Antoniou, "Digital Signal Processing:Signal System and Filter", McGraw-Hill, 2006, pp-434-453. 5.

[7] Satish Kumar, "Neural Networks: A ClassroomApproach", McGraw-Hill, 2004, pp-227-230. 6.

[8] Mohandas Choudhary "ECG SIGNAL PROCESSING WITH FIR DIGITAL FILTER BY WINDOW TECHNIQUES"Volume2, Issue 8 (August 2012).

[9] Ying-Wen Bai, "The Combination of Kaiser Window and Moving Average for the Low-Pass Filtering of the Remote ECG Signal", IEEE 2004.

[10] MATLAB-09

[11] saramaki T.,Mitra s.k., finite impulse response filter Design, handbook for digital signal processing,New York:wiley-interscience:1993.

[12] communication system:RP SINGH,SD sapre

Page468-469.

[13] Mahesh S. Chavan, R.A.Agarwala, M.D.Uplane, 'Use of Kaiser Window For ECG processing', Proceedings of the 5th WSEAS Int. Conf. on Signal Processing, Robotics and Automation, Madrid, Spain, February 15-17, 2006 (pp285-289).

[14] K.D. Chinchkhede "On the implementation of FIR Filter with various window for enhancement of ECG signal", IJEST Vol.3 No.3 March 2011.