Design IIR digital filter Using Neural Network

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Abstract: **- The paper presents the design of IIR filter using FDA tool and compare different filter that is Chebyshev type 1,chebyshev type 2 and Elliptic the using algorithm that is feed-forward back propagation using neural network. As the bsimulation results shows, the proposed neural based method is capable of archiving a better performance for filter design.**

Keywords**- FDA tool, IIR filter, low pass filter, nntool.**

Introduction

The simulation results shows as that different filter is cutoff frequency and digital filter design filter design techniques are widely used in different areas. The digital filters consist of software and hardware .The input and output signal in the digital filter is digital or discrete time sequence. Basically, digital filter are linear time invariant (LTI) system which are characterized by unit sample response these filter 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 and analysis tool (FDA Tool) is the powerful user interface for designing and analyzing filters quickly.FDA Tool permits you to design digital FIR or IIR filters by setting filter definition by importing filters from MATLAB.

Methodology

In paper using type of IIR low- pass filters that is Chebyshev type 1, Chebyshev type 2 and elliptic and different type of order that is 05, 10, 15,20,25,30,35,40,45 and 50 with the help Of FDA tool in MATLAB software, design low pass IIR filter .collect the data from FDA tool train on the artificial Neural Network using feed-forward back propagation algorithm. In research paper performance of different order filter which shows that as order increase main width lobe decrease and increasing the cut off frequency which is shown in table 1. Data had shown in table 2 and 3 train with a NN tool. In paper different order of filter selected and other parameter is given as.

Sampling frequency- 720HZ
Pass band frequency- 175HZ
Stop band frequency-275HZ
Pass band ripple- 1db
Stop band ripple-40db

Formula of calculating the cut off frequency

$$\omega_c = \frac{\omega_p + \omega_s}{2}$$

Digital IIR filter

IIR filters are one of two primary types of digital filter used in digital signal processing (DSP) application (the other type of being FIR) IIR means infinite impulse response. Impulse response is infinite because there is feedback in the filter, if you put in an impulse a signal '1' particular to convert an "ideal" impulse response of infinite duration, such as a sin function to a infinite e impulse response filter design. The ideal low pass filter is one that permits through all frequency components of a signal below a designated a cut off frequency and rejects all frequency components of a signal above .The IIR filter also known as recursive digital filter as they do not have the feedback even through recursive algorithm can be used for IIR filter realization.

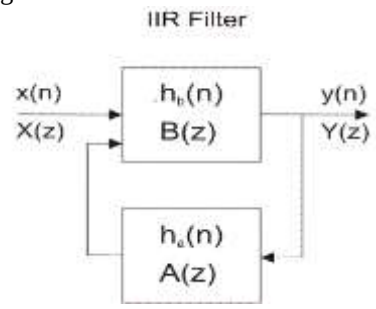
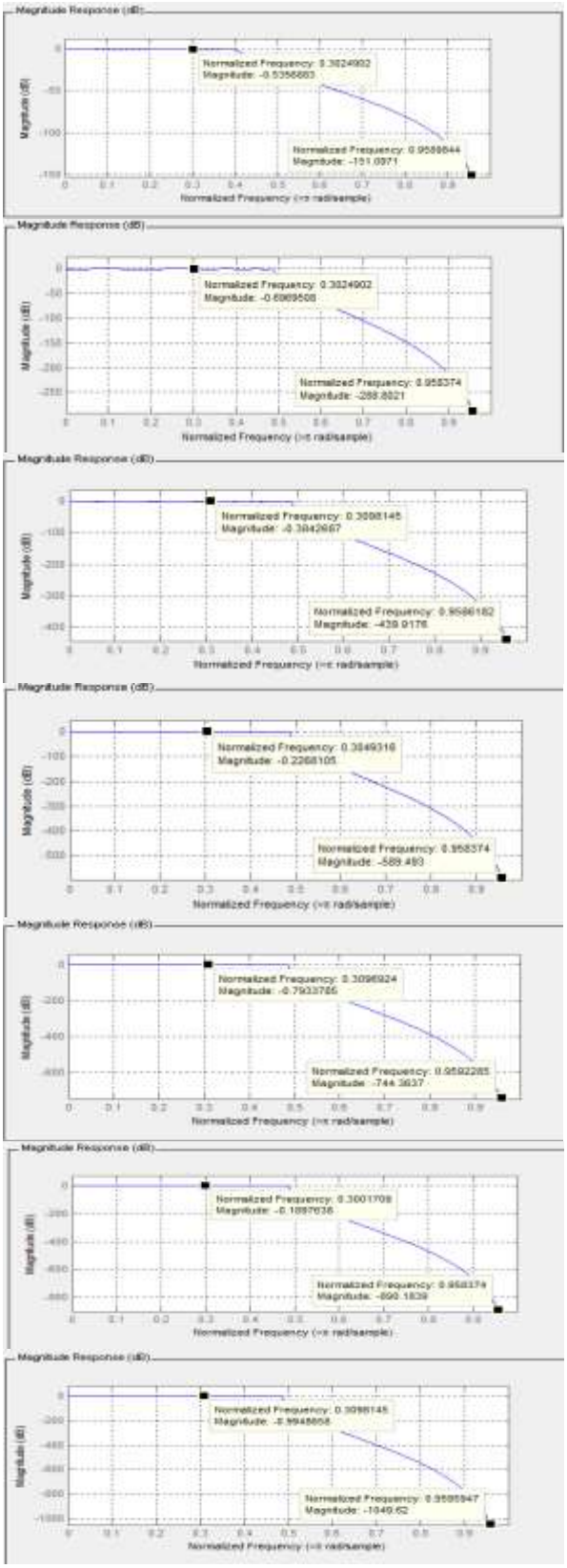
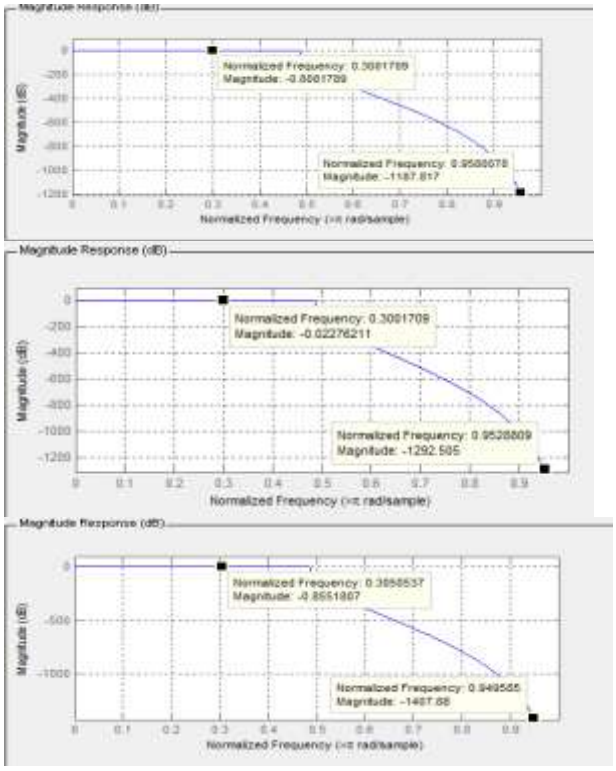


Fig (1) IIR filter

Chebyshev type 1

Analysis of the filter using Chebyshev type 1 by FDA tool in the MATLAB and the response of the filter is given in figure (2) respectively at the order 05, 10,15,20,25, 30, 35, 40,45and 50.And we get the cutoff frequency at (-3db) in HZ, Width of main lobe (db) and number of side lobe values show the table (1).

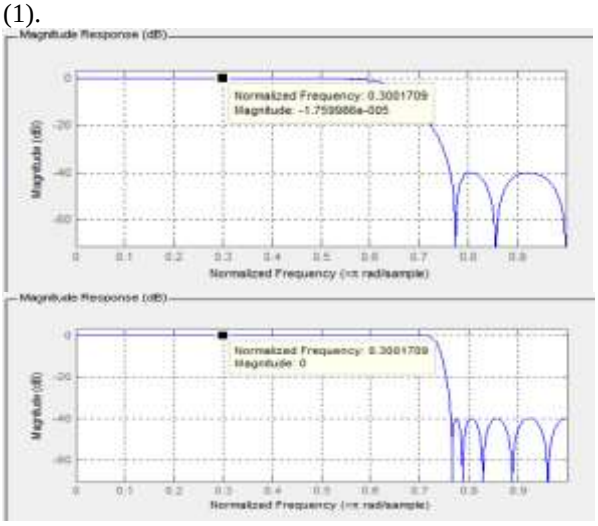


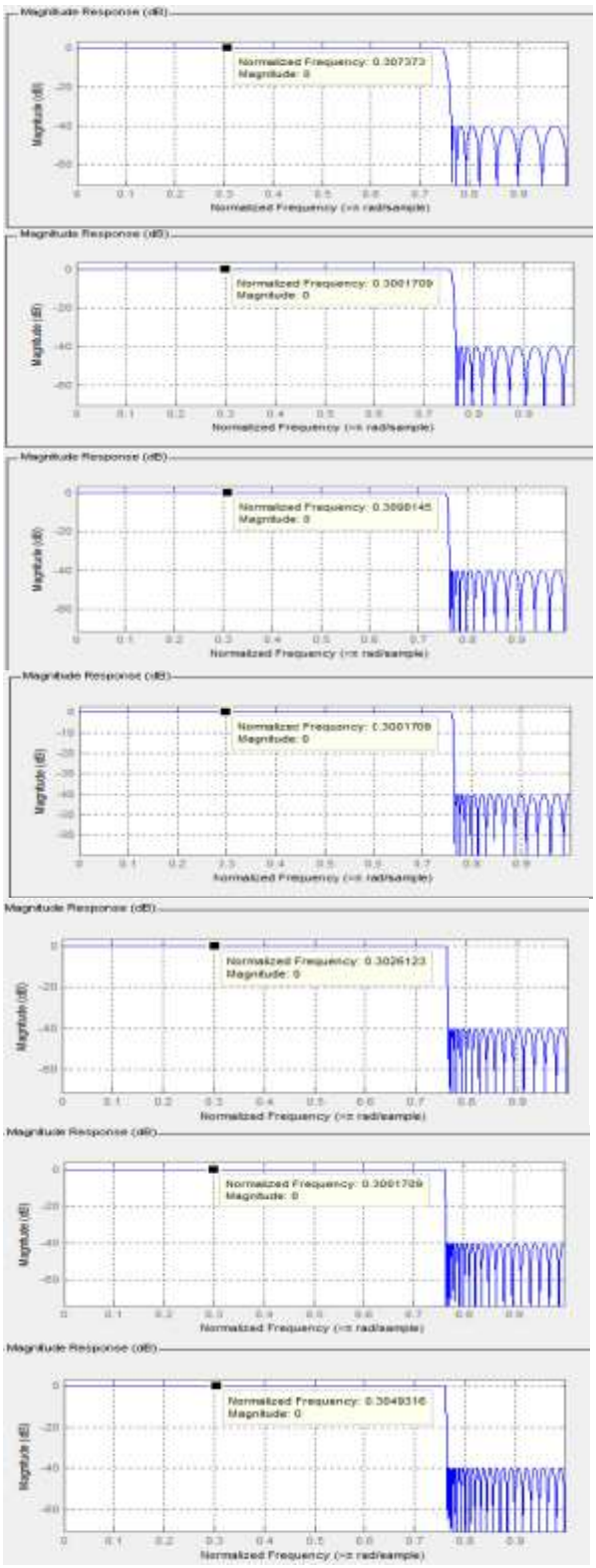


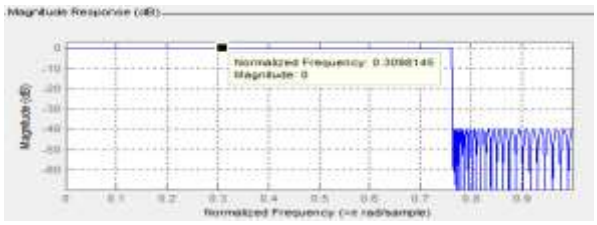
Fig(2)

Chebyshev type 2

Analysis of the filter using Chebyshev type 2 by FDA tool in the MATLAB and the response of the filter is given in figure (2- 11) respectively at the order 05, 10,15,20,25, 30, 35, 40,45and 50.And we get the cutoff frequency at (-3db) in HZ, Width of main lobe (db) and number of side lobe values show the table (1).



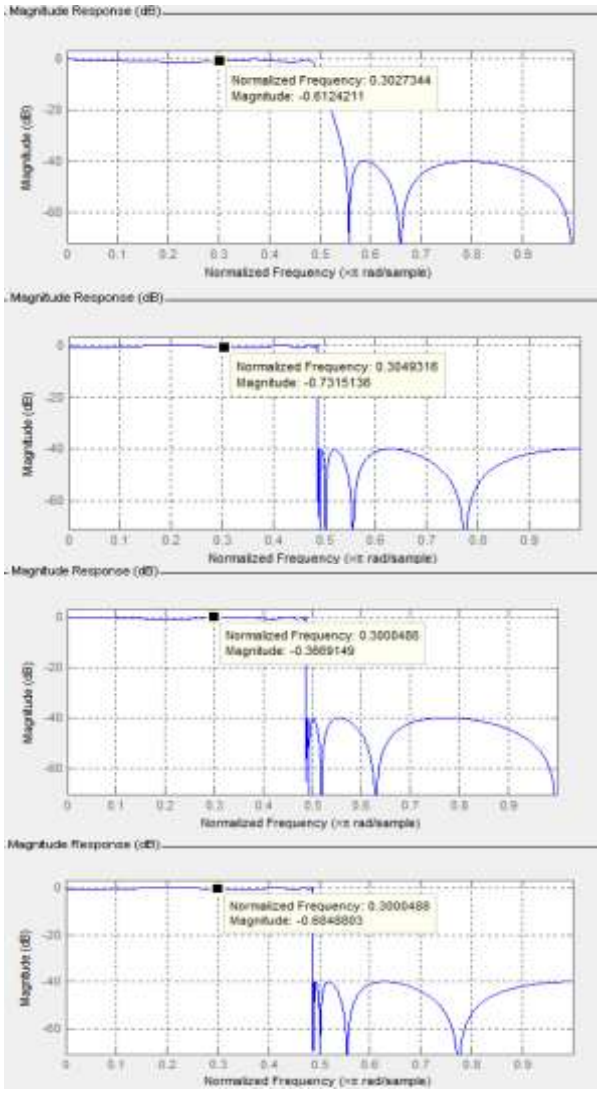




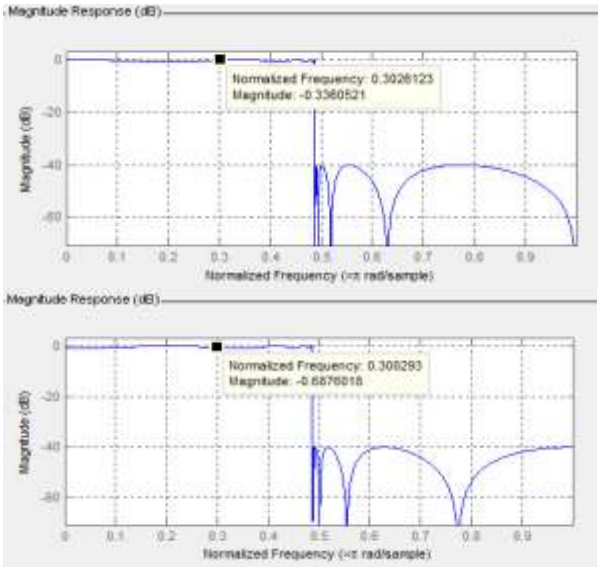
Fig(3)

Elliptic

Analysis of the filter using Elliptic by FDA tool in the MATLAB and the response of the filter is given in figure (4) respectively at the order 05, 10,15,20,25, 30, 35, 40,45and 50.And we get the cutoff frequency at (-3db) in HZ, Width of main lobe (db) and number of side lobe values show the table (1).



Filter	order	Cut 0f frequency at (-3db) in (HZ)	No of side lobe	Width of main lobe(db)
Chebyshev type 1	05	0.5356	0	0.9589
	10	0.6969	0	0.9583
	15	0.3842	0	0.9586
	20	0.2268	0	0.9583
	25	0.7933	0	0.9592
	30	0.1897	0	0.9583
	35	0.9946	0	0.9595
	40	0.8081	0	0.9580
	45	0.2276	0	0.9528
	50	0.8551	0	0.9495
Chebyshev type 2	05	1.7599	2	0.7740
	10	0	5	0.7667
	15	0	7	0.7650
	20	0	10	0.7645
	25	0	11	0.7675
	30	0	13	0.7641
	35	0	14	0.7658
	40	0	18	0.7652
	45	0	20	0.7701
	50	0	25	0.7690
Elliptic	05	0.6124	2	0.5571
	10	0.7315	4	0.4906
	15	0.3669	4	0.4877
	20	0.6848	4	0.4869
	25	0.3360	4	0.5184
	30	0.6876	4	0.4869
	35	0.3084	4	0.5184
	40	0.7132	4	0.4869
	45	0.3652	4	0.4937
	50	0.7131	4	0.4869



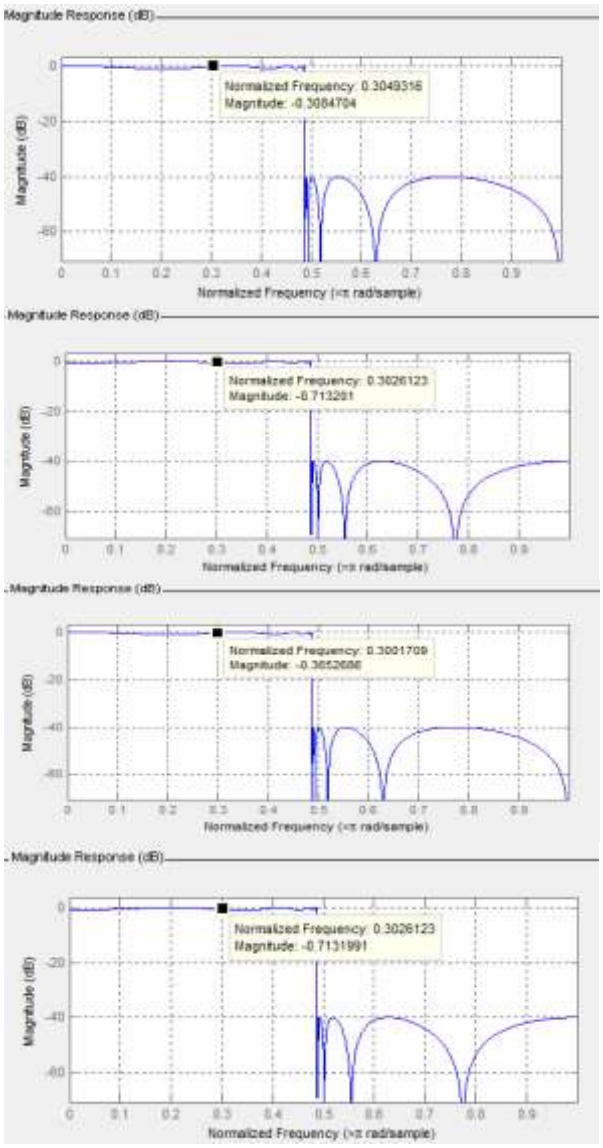
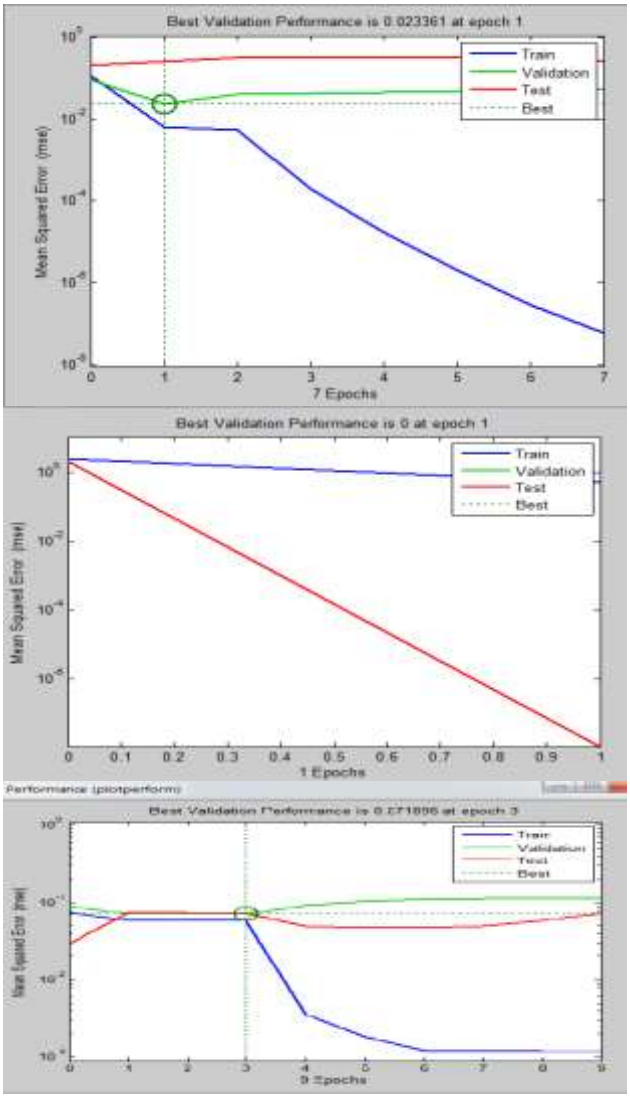


Fig (4)

Table (1)
(Comparison of different IIR Filter)

Neural Network:-

The plot obtained with respectively feed forward back propagation by the help of the neural network (nn tool) is shown below. The Figure (5) shows the best validation performance table are 2, 3 for main width lobe and for cut off frequency for low pass FIR filter.



Fig(5)

Table 2

Best validation based on order and cutoff frequency for using feed forward back propagation algorithm

IIR Filters	Best validation
Chebyshev type 1	0.023361e-001
Chebyshev type 2	0 e-00
Elliptic	0.71896e-003s

Conclusion

The paper describes comparison of different filters and calculate best validation which shown in terms of with the help of A NN tool. After training with Neural Network results shows that Best validation performance of Chebyshev type 2 Filter based on main width -lobe and cutoff frequency among three filters. 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 filters side lobe in Chebyshev type2 filter is less. Which means loss of information is less that shows in table (2).

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