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Analysis of Different IIR Filter based on Implementation Cost Performance

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Abstract- In this paper we examine the optimal implementation cost performance of various IIR Filter, which are relevant for real time application therefore these filter can realize any transfer function .these IIR filter is designed and analyzed by FDATOOL and the implementation cost has been analyzed on the basis of filter order, multiplier, adder, and input samples. The Elliptical IIR Filter is examined and comparison from the Butterworth and Chebyshev is done. The Elliptical Filter is minimize the order of filter op to 96.59% to Butterworth Filter, and 85.7% to Chebyshev .

Keywords- Filter, IIR, MATLAB, FDATOOL

I. INTRODUCTION

Digital filters are very important part of DSP. In fact their extraordinary performance is one of the key reasons that DSP has become so popular. Filters have two uses: signal separation and signal restoration. Signal separation is needed when the signal has been contaminated with interference, noise or other signals. [4]

Digital filter are used extensively in all areas of electronics industry. This is because digital filter have the potential to attain much better signal to noise ratio than analog filters and at each intermediate stage the analog filters adds more noise to signal, the digital filters performs noiseless mathematical operations at each intermediate step in the transformation. As the digital filter has emerged as a strong option for removing noise, shaping spectrum, and minimizing inter symbol interference in communication architecture. These filters have become popular because there precise reproducibility allows designing engineers to achieve performance level that are difficult to obtain to analog filter.

The basic functional need for filtering is to pass a range of frequencies while rejecting others. This need for filtering has many technical uses in the digital signal processing (DSP) areas of data communications, imaging, digital video, and voice communications. Digital signal processing techniques are being used to handle these demanding challenges in digital communications system design. Analog filters are continuous-time systems for which both the input and output are continuous-time signals. Digital filters are discrete-time systems whose input and output are discrete-time signals.

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Digital filters are implemented using electronic digital circuits that perform the operations of delay, multiplication, and addition. Infinite Impulse Response (IIR) filters based systems have sharp transition band and relatively lesser filter order. However, their susceptibility to become unstable by coefficient quantization has restricted their use in applications until recently.

II. FILTER DESIGN

FDA Tool launches the Filter Design & Analysis Tool (FDA Tool). It is a Graphical User Interface (GUI) that allows us to design or import, and analyzes digital FIR and IIR filters [6]. We have designed a low pass filter the filters of the same specifications as implemented in [6] and [8], have been synthesized using the proposed transformation for comparison We have designed a IIR filter with these specifications as shown in Figure1. MathWorks FDA tool can be used to create:

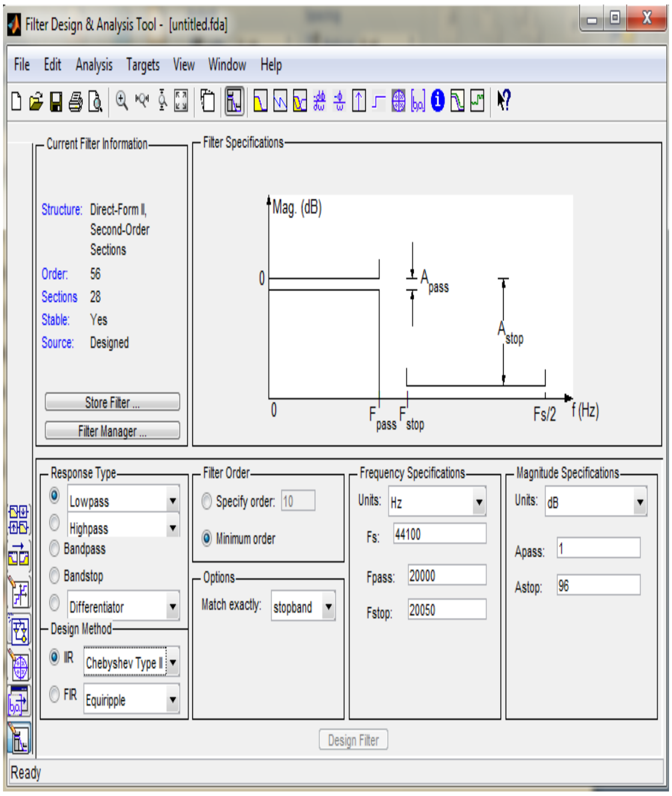

Fig 1: Design of Filter in FDA Tool

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1. Select Low pass from the dropdown menu under Response Type and under IIR Design Method. In general, when you change the Filter Type or Design Method, the filter parameters and Filter Display region update automatically.
2. Select Specify order in the Filter Order is minimum order
3. The IIR filter has an option of match exactly there are stopband, passband and both. Increasing the value creates a filter which more closely approximates an ideal equiripple filter, but more time is required as the computation increases.
4. Select the Frequency specification (Hz) Sampling Frequency is 44100 Hz, passband Frequency is 20000 Hz and stopband is 20050 Hz
5. Enter the in the magnitude specification is Apass is 1and. Astop is 96
6 After setting the design specifications, click the Design Filter button at the bottom of the GUI to design the filter

FDA Tool also provides tools for analyzing filters, such as magnitude and phase response and pole-zero plots. The classical IIR filters - Butterworth Chebyshev Types I and II and elliptic - all approximate the ideal \brick wall" filter in different ways. The Signal Processing Toolbox provides functions to create all these types of IIR filters in both the analog and digital domains and in lowpass, highpass, bandp and bandstop configurations. For most filter types, you can also find the lowest filter order that ts a given filter specification in terms of passband ripple, stopband Attenuation, and the transition band widths.

The toolbox provides different types of classical IIR filters, each optimal in some way. This section shows the basic analog prototype form for each and summarizes major characteristics

(a) **Butterworth** The Butterworth filter provides the best Taylor Series approximation to the ideal lowpass filter response at analog frequencies For the Given specification the filter order is 469 and these are the magnitude response (db) and Phase Response (radian) of Butterworth Filter

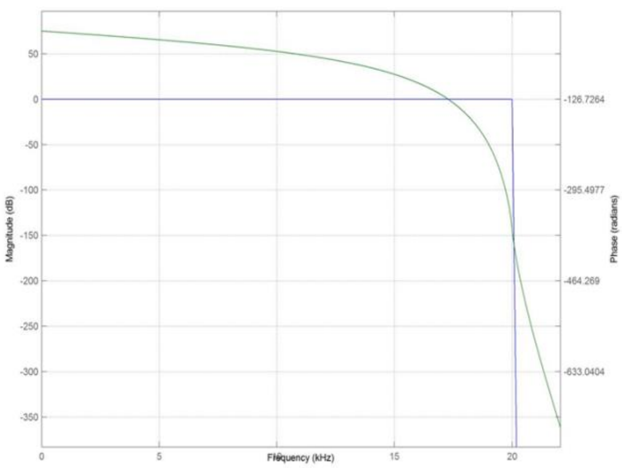


Fig 2: Magnitude response (db) and Phase Response (radian) of Butterworth Filter

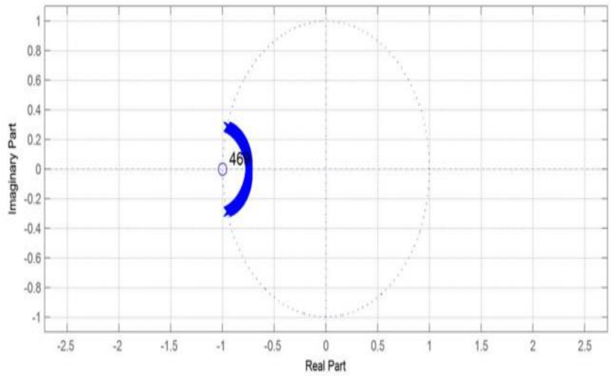


Fig 3: Pole/Zero Plot of Butterworth Filter

(b) Chebyshev Types I

The Chebyshev Type I filter minimizes the absolute difference between the ideal and actual frequency response over the entire passband by incorporating an equal rippleof Rp dB in the passband. Stopband response is maximally flat. The transition from passband to stopband is more rapid than for the Butterworth filte**r** For the Given specification the filter order is 56 and these are the magnitude response (db) and Phase Response (radian) of The Chebyshev Type I Filter

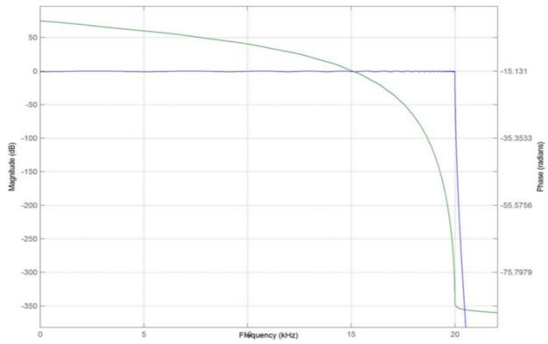
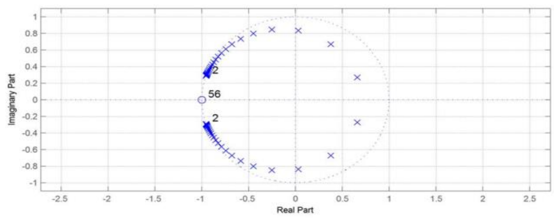


Fig 4: Magnitude response (db) and Phase Response (radian) of Chebyshev Types I Filter



(a) Fig 5: Pole/Zero Plot of Chebyshev Types I Filter

(c)Chebyshev Types II

The Chebyshev Type II filter minimizes the absolute difference between the ideal and actual frequency response over the entire stopband by incorporating an equal ripple of Rs dB in the stopband. Passband response is maximally flat.The stopband does not approach zero as quickly as the type I filter (and doesnot approach zero at all for even-valued filter order n)

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The absence of ripple in the passband, however, is often an important advantage For the Given specification the filter order is 56 and these are the magnitude response (db) and Phase Response (radian) of Chebyshev Types II Filter

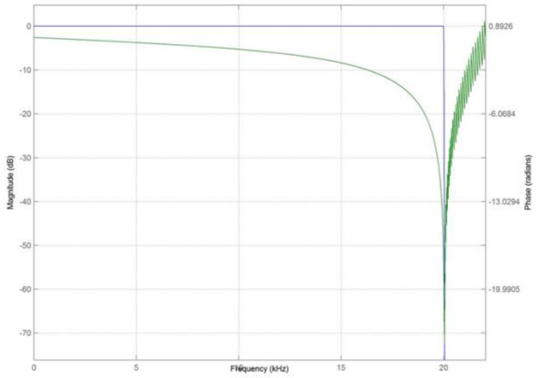

Fig 6:Magnitude response (db)and Phase Response (radian) of Chebyshev Types II Filter

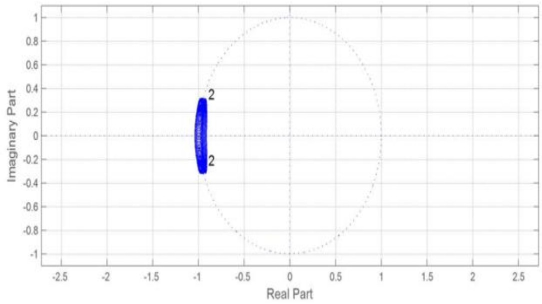

Fig 7: Pole/Zero Plot of Chebyshev Types II Filter

(d) **Elliptic Filter**

Elliptic filters are equiripple in both the passband and stopband. They generally meet filter requirements with the lowest order of any supported filter type. For the Given specification the filter order is 8 and these are the magnitude response (db) and Phase Response (radian) of Elliptic Filter

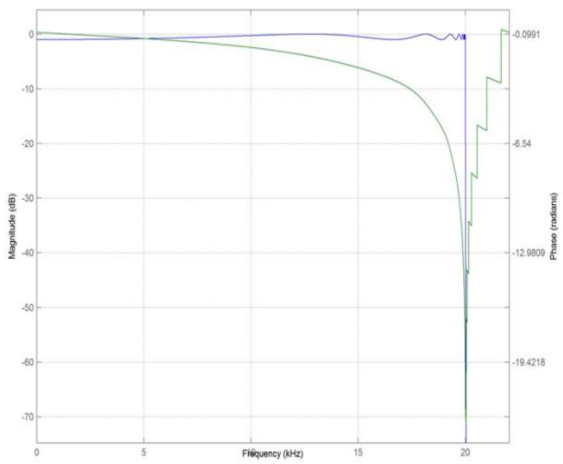

Fig 8: Magnitude response (db) and Phase Response (radian) of Elliptic Filter

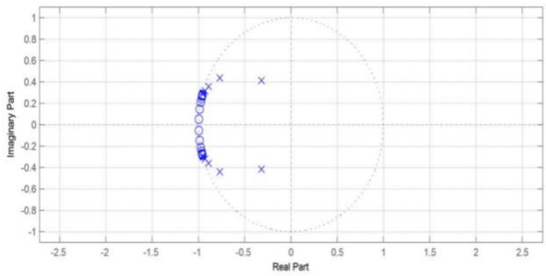

Fig 9: Pole/Zero Plot of Elliptic Filter

III. RESULTS

In order to illustrate the efficiency of the designed Hardware architecture for the IIR Filter. In Elliptical Filter, Filter order, Number of multiplier, number of adder and number of states up to 98.59%, 96.59%, 96.59%, and 98.29% as compared to Butterworth filter. whereas in comparison of elliptical Filter with Chebyshev filter the filter order, Number of multiplier, Number of Adder ,and Number of states has been reduced up to 85.7%, 71.4%, 71.4%, 85.9%

Types of filter	Filter order	Number of Multipliers	Number of Adders	Number of States
Butterworth,	469	938	938	938
Chebyshev Types I	56	113	112	112
Chebyshev Types II	56	112	112	56
Elliptic	8	32	32	16

IV. CONCLUSION

This paper includes a method for the design of fullband and lowpass IIR digital filter that would satisfy prescribed specifications has been described. Our results also show that nearly linear-phase. Elliptical IIR filter can offer some important advantages over their substantially lower computational or hardware complexity and system latency.

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