Implementation and Design of FIR Filter by Window Technique

Anand Prakash Gupta[1] , Dr.G.D Gidwani[2] , Aastha hajari[3]
anandgupta112001@gmail.com[1],ed@sksits.com[2] hajariaastha@gmail.com
M.Tech Scholar[1] professor & Executive Director[2] Assistant professor[3]
Shiv Kumar Singh Institute Of Technology & Science Indore M.P

Abstract: **The digital signal processing has become an extremely important subject. A fundamental aspect of digital signal processing is filtering. The input signal has a great influence on the performance of the system in digital control system. Processing of input signal is important to get useful signal. In the processing of digital signal Finite impulse response (FIR) filter plays an important role. Using Matlab the FIR filter is designed and simulated. Different methods like frequency sampling, window function and convex optimization technique are processed using Matlab in the design of FIR filter. By comparing the signal's amplitude-frequency diagrams which have been generated the filtering effect of different digital filters are analyzed by using FIR digital filters which are designed to process the input signal based on the Matlab function. This paper shows the experimental results show the FIR filters designed.**

1. INTRODUCTION

In signal processing, the function of a filter is to remove unwanted parts of the signal, such as random noise, or to extract useful parts of the signal, such as the components lying within a certain frequency range It is a discrete system which can do a series of mathematic processing to the input signal, due to which we can obtain the desired information from the input signal. Digital filtering is one of the most powerful tools of DSP since DSP applications are primarily algorithm that are implemented on DSP processor or in software. In both the cases a fair amount of programming is required. Using interactive software, such as MATLAB, it is now possible to place more emphasis on learning new and difficult concepts than on programming algorithms. Interesting practical examples can be discussed, and useful problems can be explored. MATLAB is a high performance language for technical computing. It integrates Computation, Visualization and programming in an easy to use environment.

1.1 FIR filter

Finite impulse response (FIR) filter is the basic elements ina digital signal processing system, and it can assurance a firm linear phase frequency characteristic with any kind ofamplitude frequency characteristic. The unit impulse response is finite; so FIR filters are stable system

1.2 IIR filter

The infinite impulse response (IIR) filter has a feedback loop and is recursive structure, and it. IIR filters are not linear phase and the precision of amplitude frequency characteristic is very high.

1.3 Comparison of FIR and IIR

- For the same conditions as in the technical indicators, there is a feedback to the output of the IIR filter from the input, so it meet the requirements better than FIR. It is more economical because the storage units are less than those of IIR, and, the number of calculations is also less in IIR.
- The phase of the IIR filter is not linear while the FIR filter the phase is strictly linear.
- In FIR filter finite precision arithmetic error is very small and has a non-recursive structure. While IIR filter parasitic oscillation may occur in the operation of IIR filter and has a recursive structure.
- Fast Fourier Transformation cannot be used in IIR but can be used in FIR filter.

There are essentially three well-known methods for FIR filter design namely:
(1) The window method
(2) The frequency sampling technique
(3) Optimal filter design methods
Of the above three the major advantages of using window method is their relative simplicity as compared to other methods and ease of use.(So are more popular).The fact that well defined equations are often available for calculating the window coefficients has made this method successful.

2. WINDOW FUNCTION

Most digital signals are infinite, or sufficiently large that the dataset cannot be manipulated as a whole. Sufficiently large signals are also difficult to analyze statistically, because statistical calculations require all points to be available for analysis. In order to avoid these problems, engineers typically analyze small subsets of the total data, through a process called windowing.
Windowing is the process of taking a small subset of a larger dataset, for processing and analysis. Application of a window to a dataset will alter the spectral properties of that dataset. In a rectangular window, for instance, all the

data points outside the window are truncated and therefore assumed to be zero. The cut-off points at the ends of the sample will introduce high-frequency components.

Different types of windows are:

1) Rectangle Window
2) Kaiser Window
3) Hanning window
4) Hamming window

2.1 Rectangle Window

In this a sample of infinite duration is truncated at point say at n=M-1 to yield an FIR filter of length M.Trancation of $h_d(n)$ to a length M-1 is equivqlebt to multiplying $h_d(n)$ by a "rectangular window" defined as

$$w(n)= \begin{cases} 1, & n=0,1,2.....M-1 \\ 0, & otherwise \end{cases}$$

2.2 Kaiser Window:

Mathematically Kaiser Window is defined as

$$W(n) = \frac{I_o(\alpha \sqrt{1-(n-M)^2 / M^2})}{I_o(\alpha)}$$

$I_o(\alpha)$ is modified Bessels function of the first kind and 0^{th} order.

2.3 Hanning window

The Hann window named after Julius von Hann and also known as the Hanning window and is defined by

$$W(n)= 0.5\left[1- \cos\left(\frac{2\pi n}{N-1}\right)\right]$$

It is also defined in term of haversine function

$$W(n) = hav\left(\frac{2\pi (n}{N-1)}\right)$$

2.4 Hamming window

Mathematically Hamming is given by

$$W(n) = 0.54+ \cos\left(\frac{2\pi n}{N-1}\right)$$

3. SIMULATION

The realization of FIR filter is done on MATLAB tool.

Magnitude response of various windows:

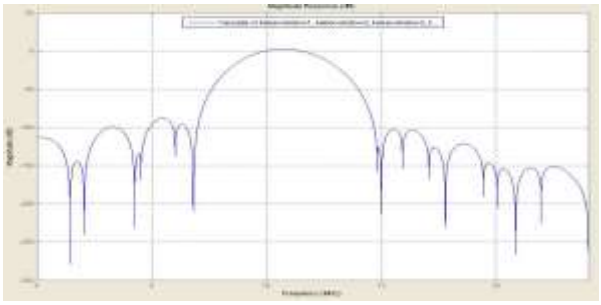

Fig.1 Kaiser Window

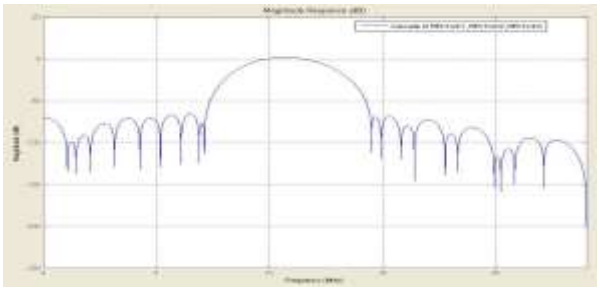

Fig.2 Rectangular Window

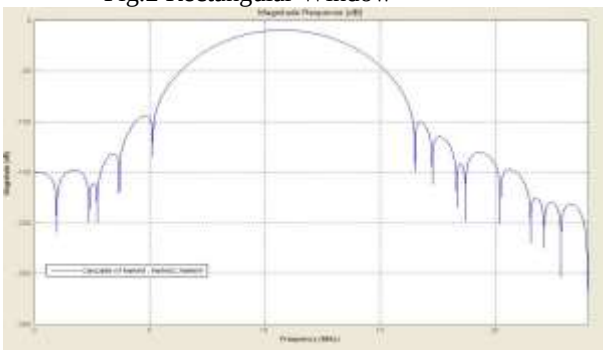

Fig.3 Hamming Window

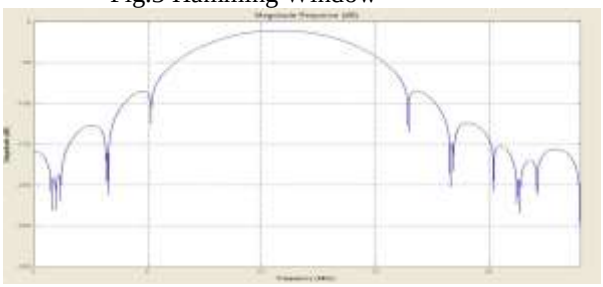

Fig.4 Hanning Window

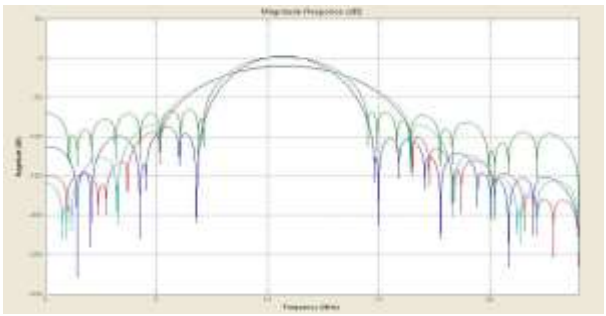

Fig.5 Comparison of Windows technique for

FIR Filter

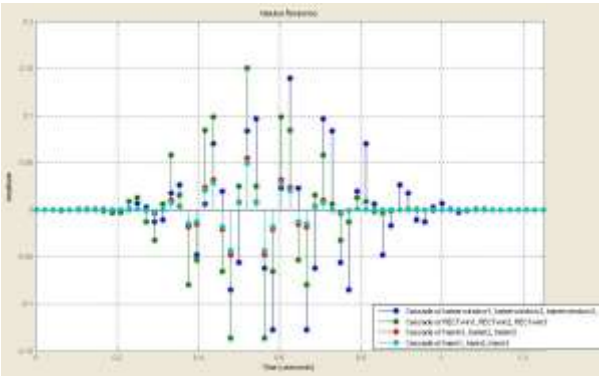

Fig.6 Impulse response of FIR Filter with Different Window technique

4. RESULT

The comparison parameter of various windows for FIR filter is considered and compared in the table 4.1. The value of β is take as 10,15,25 for all the windows. The cutoff frequency is fixed at 6db.

Window Technique	Filter Type	Sampling Frequency
Kaiser	Band Pass Filter	Sampling Frequency is fixed at 48Khz
Rectangular	Band Pass Filter	
Hamming	Band Pass Filter	
Hanning	Band Pass Filter	

Table 4.1

5. CONCLUSION

The paper represents the design of FIR filter with various windows technique. Although there are various windows but the Kaiser window in found to best as it has the flexibility of choosing parameter independently,

I like to thank Dr. G.D Gidwani (professor and Executive Director) and Miss Aastha Hajari(Assistant Professor) for guiding me in completion of my thesis work. I also like to thank all the staff members of SKSITS for helping to reach my goal.

6. REFERENCES

[1]. Sonika Gupta, Aman Panghal Performance "Performance Analysis of FIR Filter Design by Using Rectangular, Hanning and Hamming Windows Methods" International Journal of Advanced Research in Computer Science and Software Engineering Volume 2, Issue 6, June 2012.

[2]. Prof.GopalS.Gawande, Dr.K.B.Khanchandani, T.P.Marode "performance analysis of fir digital filters design techniques" International Journal of computing & corporate research volume 2 issue 1 January 2012.

[3]. Najat Sh.Jasim Mohammed "The Performance Enhancement Study of FIR Filters Based on Adjustable Window Function" Eng a& Tech Journalvol30,no.5,2012.

[4]. GAO Jinding, HOU Yubao, SU Long. "Design and FPGA Implementation of Linear FIR Low-pass Filter Based on Kaiser Window Function" Fourth International Conference on Intelligent Computation Technology and Automation in proceeding IEEE pp.496-498, 2011.

[5].Yunlong,W., Shihu,W., Rendong,J., "An Extreme Simple Method for Digital FIR Filter Design" in proc. Third International Conference on Measuring Technology and Mechatronics Automation (ICMTMA), IEEE, vol. 1, pp. 410-413, 2011.

[6]. Mahrokh G. Shayesteh and Mahdi Mottaghi-Kashtiban "FIR filter design using a new window function" in proceeding IEEE 978-1-4244-3298-1/09,2009.

[7].Hou, Z. R. & Lv, Z. S. (2003). Particle Swarm Optimization Algorithm for IIR Digital Filters Design. Journal of Circuits and Systems, Vol.8, No.4 , (Apr. 2003) 16-20, ISSN 007-0249

[8].Kalinlia, A. & Karaboga, N. (2005). Artificial Immune Algorithm for IIR Filter Design.International Journal of Artificial Intelligence, Vol.18, No.8 , (Aug. 2005) 919-929, ISSN 0974-0635

[9].Karaboga, N., Kalinli, A. & Karaboga, D. (2004). Designing digital IIR filters using ant colonyoptimisation algorithm. Engineering Applications of Artificial Intelligence, Vol.17, No.6 , (Jun. 2004) 301-309, ISSN 0952-1976

[10].Li, X.; Zhao, R. C. & Wang, Q. (2003). Optimizing the Design of IIR Filter via Genetic Algorithm, Proceedings of IEEE International Conference on Neural Networks for Signal Processing, pp. 476-479, ISBN 0-7803-8177-7, Nanjing, China, Sep. 2003

[11].Seo, J. -H., Im, C. -H, Heo, C. –G., Kim, J. –K., Jung, H. –K. & Lee, C. –G. (2006). Multimodal Function Optimization Based on Particle Swarm Optimization. IEEE Transactions on Magnetics, Vol.42, No.4, (Apr. 2006) 1095-1098, ISSN 0018-9464

[12].Shi, Y. & Eberhart, R. C. (1998). A Modified Swarm Optimizer, Proceedings of the IEEE International Conference of Evolutionary Computation, pp. 69-73, Anchorage, USA, May. 1998.

