IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 11, Issue 6 Ver. I (Nov. – Dec. 2016), PP 87-89
www.iosrjournals.org

A Survey on Efficient Optimization Technique for Finite Impulse Response Filter

Alamdeep Singh[1], Prof.Manit Kapoor[2], Dr. Naveen Dhillon[3]
[1]Student RIET Phagwra,[2] Assistant Professor, [3]Professor

Abstract: *Improvements are required to be made in coefficients for better design and optimization of digital filters. The digital filter considered here is Finite Impulse Response (FIR) filter that is used widely in modern digital applications likewise speech processing, image processing, signal enhancement, digital audio etc. Many theories have been put forward for the optimization of FIR filters. Various filter parameters likewise filter length, passband and stop band frequencies, cut off frequency, ripple size, attenuation factor and Weighting factor are being analysed. Also, the optimization techniques such as Differential Evolution(DE), Genetic Algorithm(GA), Particle Swarm Optimization(PSO), Simulated Annealing(SA) etc. are being considered. For better optimization magnitude response of both symmetric and non – symmetric FIR filter. The efforts are made so as to have reduced computational effort, hardware cost and better optimization results.*

Index Terms: *Differential Evolution (DE), Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Simulated Annealing (SA), Weighting Factor etc.*

I. Introduction

A digital filter is a filter that is known for performing mathematical operations on a sampled, discrete-time signal so as to reduce or enhance certain aspects of that signal. For the design of a digital filter system,firstly, an analog-to-digital converter is used to sample the input signal, followed by a microprocessor and some peripheral components such as memory for storing the data and filter coefficients etc. Then, finally a digital-to-analog converter completes the output stage.

The digital filters are mainly classified as the Infinite Impulse Response (IIR) filters and Finite Impulse Response (FIR) filters. The FIR filters are widely used because of their linear phase response and stability due to the absence of poles in their transfer function. The multiplication and accumulation of filter coefficient with input data are the basic operations of FIR filters and this is realised using the multipliers and adders. Basically the multipliers are the area consuming and power circuits which are quite complex in nature so these are replaced using the shift and adder circuits

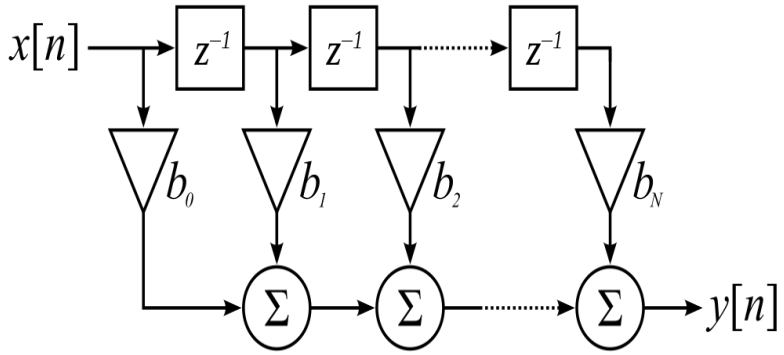

Figure 1: Discrete time filter of order N.

There are various advantages of FIR filters. Some of them are listed as follows:-

- Require no feedback:- This implies that any rounding errors are not compounded by summed iterations. So, this also makes implementation simpler.
- These are inherently stable:-The output is a sum of a finite number of finite multiples of the input values.
- These can be easily be designed to belinear phase by making the coefficient sequence symmetric.

Various optimization techniques are being developed over the time. The survey of such techniques is done here.

II. Literature Survey

Ling Cen [5] presented a technique known as hybrid genetic algorithm for the better design of FIR filter using the signed power – of – two (SPoT) terms. The optimization carried is non- linear in nature that considers the design of SPoT based FIR filters. The optimization is done using the hybrid genetic algorithm (GST). The scheme is used by integrating the features of simulated annealing (SA), Adaptive Genetic Algorithm (AGA) and the tabu search algorithm. AGA is considered for the varying population size and also for the varying varying genetic probabilities i.e. used for the hybridization. SA is used when it is clear that AGA might not give better results in local optimum. The SA on combined use with AGA gives the better convergence. Further, to increase the convergence of both AGA and SA, the tabu search algorithm is used. The convergence criteria is carried out on the filter parameters. The simulation results show that the hybrid GA (GST) gives the better results as it normalizes the peak ripples of filter and improves the computational effort.

Jehad I. Ababnehet. al [4] proposed a novel method to design the FIR filter using the genetic algorithm (GA) and particle swarm optimization (PSO). The design of Linear phase FIR filter is carried out for the filter coefficients with finite word length using the PSO and GA . For this two design steps are followed: firstly, the passband and stopband frequencies, filter length and the ratio of passband and stopband ripple size are known. Secondly, the size of ripples in both the passband and stopband along with other three filter specifications are known. The PSO technique is followed because of its ability to solve the multidimensional optimization problems and provides the global optimal solution whereas the GA is based on the theory of finding the fittest survival among the population. The comparison is made between both the algorithm using the finite word length (M), passband frequency (ωp) and stopband frequency (ωs) and the ratio of passband and stopband ripple size ($\delta p/\delta s$). On comparing, it is concluded that PSO gives the better results than the GA for both finite and infinite word length frequencies.

Shian – Tang Tzeng [6] proposed a novel method for the design of 2-D FIR digital filter using genetic algorithm with given magnitude and group delay response. The GA is used by minimizing the quadratic measure of error in the frequency band. For finding the filter coefficients, the chromosomes are evolved. The proposed method is used for the multi-band filters and all pass phase equalizers. The delay response is calculated for the 2D filters i.e. $\tau_1$and τ_2. The maximum group delay, τ_{1max} = 4.47 and minimum group delay τ_{1min} = 3.8029 and the τ_{2max} = 4.45 and the τ_{2min} = 3.81. Therefore, the new evolutionary algorithm is evolved for minimizing the quadratic error in frequency band.

BipulLuitel et al [2] presented a novel method for optimization of digital filter using differential evolution. For the study, two optimization techniques are followed i.e. Particle Swarm Optimization (PSO) and the Differential Evolution Particle Swarm Optimization (DEPSO). The PSO is used on the basis of passband and stopband ripple while DEPSO considers the fitness function using the mean squared error. The coefficients of filter are optimized so as to have the better frequency response. The ripple size in the passband ,δp is 0.1 and in stopband,δs is 0.01 . Also, the passband and stopband cut off frequency is 0.25 and 0.3 respectively. The population size is taken as 25 for both the PSO and DEPSO. The basic need to optimize the coefficients is through their fitness, for this hybridization is done that provides the global solution and prevents the particles to get trapped in local minima. The simulation results show that the DEPSO is better for the optimization of digital filters.

Abhijit Chandra et al [1] proposed a novel method to design a multiplier – less FIR filter using Differential Evolution Algorithm. For this, the quantization and optimization operations are followed. The word length is taken as 8. The passband and stopband edge frequency are taken as 0.25 rad/pi and 0.5 rad/pi respectively. The attenuation of passband and stopband attenuation is 1 dB and 50 dB respectively. Differential Evolution Algorithm is better option shown.

Table1 shows the survey of various optimization techniques.

Sr. No.	Paper Title	Techniques Followed	Results
1	Linear phase FIR filter design using particle swarm optimization and genetic algorithms	Particle swarm optimization and genetic algorithms	Particle swarm optimization gives better results for both finite and infinite word length.
2	A hybrid genetic algorithm for the design of FIR filters with SPoT coefficients	Genetic Algorithm, Hybrid Genetic Algorithm, Simulated Annealing, Adaptive Genetic Algorithm and Tabu Search Algorithm	Hybrid Genetic Algorithm proved as better results as it normalizes the peak ripples of the filter.
3	Design of 2-D FIR digital filters with specified magnitude and group delay responses by GA approach	GA approach is followed for the design of 2-D filters	Reduces the quadratic measure of error in frequency band following the evolutionary algorithm.
4	Differential Evolution Particle Swarm Optimization for	Particle swarm optimization and Differential Evolution Particle	Differential Evolution Particle Swarm Optimization gave the better results as it

	Digital filter design	Swarm Optimization	prevents the particles to get trapped in local minima.
5	Novel approach of designing Multiplier-less Finite Impulse Response filter using Differential Evolution Algorithm	Operation of quantization and optimization are followed with Differential Evolution Algorithm	Differential Evolution Algorithm is followed as it reduces the response and hardware requirement.

Dong Shi et al [3] presented a technique to design the discrete – valued Linear Phase FIR filter in cascade form. This is achieved to have lower coefficient sensitivity, higher throughput, reduced computation and lower implementation cost. Here, a linear phase finite impulse response filter is used with discrete coefficients.The method used decomposes the overall filter to sub-filters to know the overall response of the filter. The subfilters are both symmetric and non-symmetric in nature. The modification is done in conventional recursive search process.

Ranjit Singh Chauhan et al [6] presented a novel method for the optimal design of FIR filter using the Genetic Algorithm. The digital filter is mainly nonlinear and multimodal in nature so the global optimization techniques are used so as to avoid the local minima. Impulse response is finite in nature. For this following specifications are used i.e. passband ripple (r_p) = 0.1 dB , stopband ripple (r_s) = 40 dB, passband frequency (f_p) = 150 Hz , stopband frequency (f_{sb}) = 250 Hz and sampling frequency (f_s) = 1000Hz. The evolutionary results are obtained on using the genetic algorithm for better and quick response.

S. Chattopadhyay et. al [8] presented an optimization technique of Differential Evolution Algorithm for efficient design of FIR filter. Here, the control parameter i.e. weighting factor is used for the convergence of differential evolution algorithm. The QPSK modulation technique is used and analysis is carried out using the eye diagrams. The simulation results show that the Weighting factor of 0.7 is better for optimization using the differential evolution.

III. Conclusion

On surveying the various papers, it can be concluded that the Differential Evolution Particle Swarm Optimization (DEPSO), Genetic Algorithm (GA), Hybrid Genetic Algorithm (GST) have proved to be better optimization techniques. The analysis is carried out using the filter parameters likepassband and stops band frequencies, cut off frequency, ripple size, attenuation factor and Weighting factor. The simulation results are also carried out using the eye diagrams and magnitude response of different filter length. The efforts are made so as to have the reduced computational efforts andhardware cost.

References

[1]. Abhijit Chandra, Sudipta Chattopadhyay, " Novel approach of designing Multiplier-less Finite Impulse Response filter using Differential Evolution Algorithm" , published in I.J. Intelligent systems and Applications, 2012, Vol.4,Page 54-62.

[2]. BipulLuitel, Ganesh K. Venayagamoorthy, " Differential Evolution Particle Swarm Optimization for Digital filter design",IEEE Transaction,2008,page 3954-3961.

[3]. Dong Shi, Ya Jun Yu, " Design of Discrete – Valued Linear phase FIR filters in cascade form" , IEEE Transactions on Circuits and Systems,2011, Vol. 58,No. 7,Page 1627-1636.

[4]. Jehad I. Ababneh, Mohammad H. Bataineh, " Linear phase FIR filter design using Particle Swarm Optimization and Genetic Algorithm",2008, Vol.18,Page 657-668.

[5]. Ling Cen , " A hybrid genetic algorithm for the design of FIR filter with SPoT coefficients" published in Conference of Signal Processing ,2007, Vol. 87, Page 528-540.

[6]. Ranjit Singh Chauhan, Sandeep K. Arya, " An optimal design of FIR digital filter using Genetic Algorithm",2011,in Conference of CCIS, page 51-56.

[7]. Shian- Tang Tzeng," Design of 2D FIR filter with specified magnitude and group delay responses by GA approach", 2007, vol. 87, Page 2036-2044.

[8]. S.Chattopadhyay,S.K. Sanyal , A. Chandra," Optimization of Control Parameters of DE alogorithm for efficient design of FIR filter" , in the proceedings of 13th International Conference on Computer and Information Technology,2010, page 23-25.

[9]. W.H. Press, S.A. Teukolsky, W.T. Vettering, B.P. Flannery, Numerical Recipes in FORTRAN, second ed., Cambridge University Press, New York, 1992.

[10]. Z.H. Cui, J.C. Zeng, " An adaptive nonlinear genetic algorithm fornumerical optimization" , in Proceedings of the First IEEE International Conference on Machine Learning and Cybernetics, vol. 3, 2002, pp. 1559–1561.