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Research Article

Implementation of Different Neural Network Techniques for Designing Linear Phase FIR Filter

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Abstract

Digital filters live wide used in utterly completely different areas. they are easier in storage and maintenance. As there's a wonderful advancement a la mode techniques for diverse digital filters. vogue techniques once the first windowing methodology, there unit another approaches put together that suffer from some moderately drawbacks i.e. variety of them could not offer optimum vogue in any sense, some unit lacking of generality, and a number of needs long computing then on.in this paper we tend to ar bestowed simulation results of designed FIR filter exploitation BPNN,ADALINE and HNN formula. The comparison is finished between the standard methodology, varied authors results and planned design.

Keywords: *BPNN, ADALINE, HNN, FIR Filter*

1. Introduction

ANN has been wide employed in the appliance of communication systems **[**Robert J Schalkoff *et al*,1997]. The ANN is networks of easy process parts known as neurons. they're connected to every different by weights. every nerve cell multiplies the incoming signals by the corresponding weights and sums then up[Simon Haykin *et al*, 2005, S N Sivanandam and S Sumathi *et al* ,2006]. If this add or the activation price is quite threshold, the nerve cell changes its output. The network is trained to adjust its weights within the learning section. Still, the network is in a position to perform some task a lot of simply than a conventional laptop as a result of huge property and parallel operations of all the weather. It resembles brain in 2 respects:

1. A neural network acquires data through learning.
2. A neural network's data is keep at intervals inter-neuron association strengths referred to as colligation weights.

Artificial Neural Networks ar being counted because the wave of the longer term in computing. They are so self-learning mechanisms that do not need the standard skills of a computer user. Currently, only a few of those neuron-based structures, paradigms really, are being employed commercially. The power and utility of artificial neural networks are incontestable in many applications together with speech synthesis, diagnostic issues, medicine, business and finance, robotic management, signal process, laptop vision and lots of different issues that constitute the class of pattern recognition. for a few application areas, neural models show promise in achieving human-like performance over a lot of ancient computer science techniques.[S.N.Sivanandam and S Sumathi *et al*, 2006]

Digital filters are widely used in different areas. They are easier in storage and maintenance. As there is a great advancement in design techniques for various digital filters. Design techniques after the early windowing method, there are some other approaches also that suffer from some kind of drawbacks i.e. some of them could not give optimal design in any sense, some are lacking of generality, and some needs long computing **[**A. V. Oppemheim, and R.W. *Schafer et al, 1989***]** and so on.We also design the FIR filters in neural network domain and get the optimized result.

2. Algorithm

1. Set initial iteration number k=0, weights acceleration factor α, stop criterion ε, and initial weight $W_o(\omega_t)$ for $1 \le l \le L$.
2. The parameter of HNN such as C_i, R_i, λ, b and initial input $u_{i,o}(0)$ for all I neurons are also set.
3. For the k-th iteration, calculate T_{ij} and I_i.

T_{ij}= - $\sum_{l=1}^{L} W(\omega_l)\varphi_i(\omega_l)\varphi_i(\omega_l)$,

I_j= $\sum_{l=1}^{L} W(\omega_l)\breve{A}(\omega_l)\varphi_i(\omega_l)$

$p = M - n_0 + 1$

Where $n_0 \le i, j \le M$

T_{ij} = Interconnection strength

$I_j = bias\ current$

Run the HNN for 5μs to obtain the optimal filter coefficient $a_{n,k} = \frac{u_{n,k}(t=5\mu s)}{\lambda}$

Use the final state $u_{n,k}$ of the HNN as the initial condition for the optimization of the next iteration, i.e.

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$u_{n,k+1}(0) = u_{n,k}(t = 5\mu s)$.

Compute the error responses

$E_k(\omega_l) = |\breve{A}(\omega_l) - A_k(\omega_l)|$.

Where,

$A_k(\omega_l) = \sum_{n=n_0}^{M} a_{n,k}\varphi_n(\omega_l)$ is the designed amplitude response calculated at the k-th iteration. Check for the stopping condition

$$\frac{peak\_max - peak\_min}{peak\_\ max} \leq \varepsilon.$$

If the condition is satisfied , we terminate the design process. Otherwise, set k=k+1 and go to step 5.

Use the error response calculated from step 4, to calculate new weights

$W_{k+1}(\omega_l) = W_l(\omega_l)\beta_k(\omega_l)$, for 1≤l≤L

Where, the error function $\beta_k(\omega_l)$ at k-th iterarion calculated as

$$\beta_k(\omega_l) = \frac{1}{peak\_max} \frac{|E_k^{a}(\omega_l)|}{\sum_{l=1}^{L}[W_k(\omega_l)|E_k^{a}(\omega_l)|]}$$

The parameter α is an acceleration factor that affects the convergence and the convergence speed of the proposed algorithm. It can be found from several references in the literature **[**S. Russell, D. Edwards, P. Canny *et al*, 1995, Yuichi Kida & Takuro *et al*, 2010, J. A. Freeman and D. M. Skapura *et al*, 1991**]** that the value of α in the range 1.0 ≤ α ≤ 1.5 has the best convergenc performance.

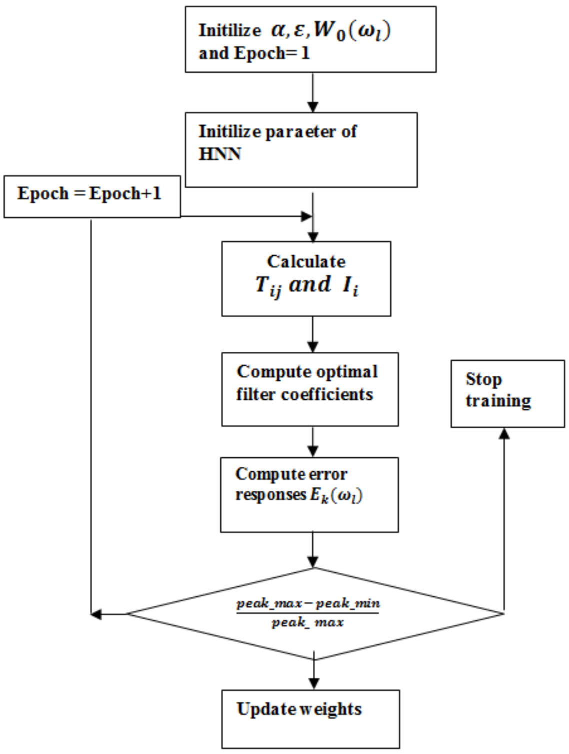

Fig (a) Flow chart of Hopefield Neural Network algorithm

3. Simulation Results

(a) Simulation result of back-propagation algorithm

In figure-1 and figure-2 the results of linear phase low-pass FIR filter are shown which is designed by the conventional method and BPNN algorithm respectively.The parameters of designing linear phase low-pass FIR filter are **[**Xiaohua Wang & Xianzhi Meng *et al* ,2006**]**. The BPNN **[**A. Antoniou and D.*Bhattacharya et al, 1996***]** algorithm is an approximation algorithm from the results shown we conclude that it is an alternative approach of designing FIR filters. The *root mean square* (Rmse) **[**X. P. Lai *et al*, Mar. 1999**]** for the architecture is 4.8573e-004. Figure-3 shows the comparison between the magnitude responses of conventional method design and BPNN method design of linear phase low-pass FIR filter **[**A. Antoniou and D.Bhattacharya *et al*, 1995, Hui Zhao and Juebang Yu *et al*, 1997, A. Antoniou and D.Bhattacharya *et al*, 1996**]**.

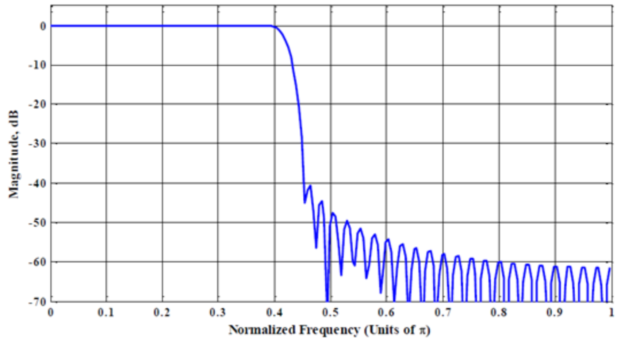

Fig.1 Magnitude response of low-pass FIR filter using least square method

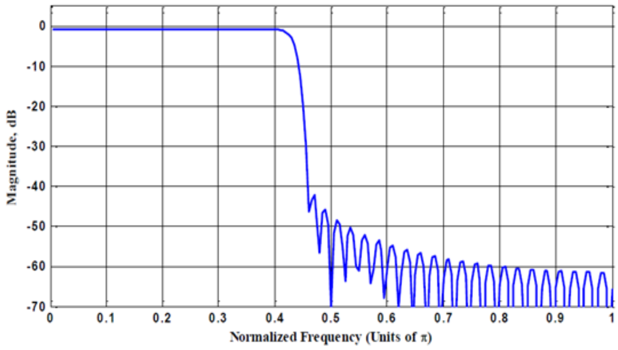

Fig.2 Magnitude response of low-pass FIR filter using Back propagation method

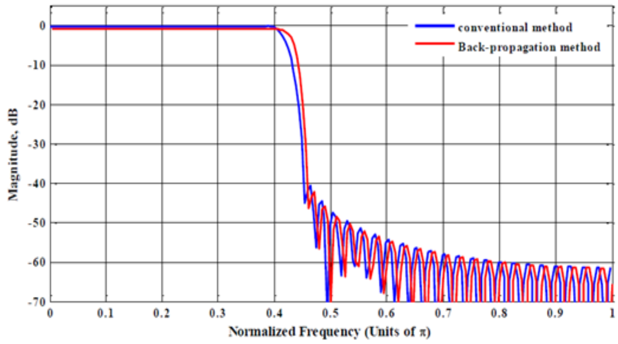

Fig.3 Comparision of Magnitude response of least square & Back propagation method

(b) Simulation result of ADALINE algorithm

In figure-4 the results of linear phase low-pass FIR filter are shown which is designed by the conventional method. The parameters of designing linear phase low-pass FIR filter are [Y. D. Jou and F. K. Chen *et al,* May. 2007]. From the result of least square design we have passband ripple and stopband ripple. In figure-5 the results of linear phase low-pass FIR filter are shown which is designed by the neural network optimization (NNO) method [Y. D. Jou and F. K. Chen *et al,* May. 2007]. The parameters of designing linear phase low-pass FIR filter are same as used for convention method. From the result of NNO design we have passband ripple and stopband ripple.[X. P. Lai *et al,* Mar. 1999, A. Antoniou and D.Bhattacharya *et al,* 1996, Hui Zhao & Juebang Yu *et al,* June 1997]

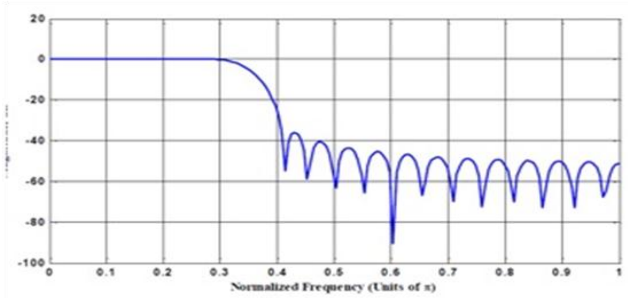

Fig.4 Magnitude response of low-pass FIR filter using proposed NEURAL NETWORK

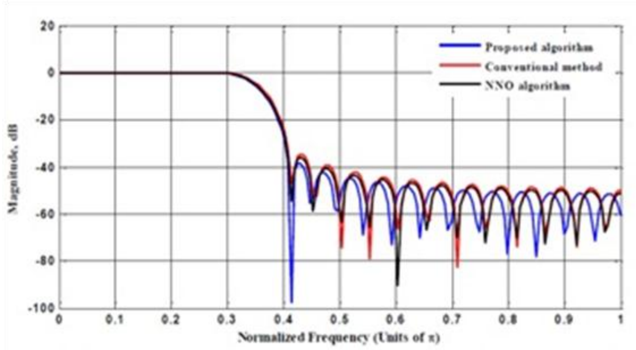

Fig.5 Comparision of Magnitude response of low-pass FIR filter using various methods

4. Results & Discussion

Table 5.1 Performance comparison of least square & ADALINE method

Design method	Length	$\omega_p(\pi)$	$\omega_s(\pi)$	$\delta_p(dB)$	$\delta_s(dB)$	No. of neurons
Conventional method	31	0.30	0.34	20.53	21.22	N/A
Neural network optimization(NN)	31	0.30	0.34	22.49	21.41	16
Proposed ADALINE method	31	0.30	0.34	23.03	21.56	16

We discussed about the MATLAB simulation results of designed FIR filter using BPNN, ADALINE and HNN algorithm. The comparison is done between the conventional method, various authors results and proposed architecture.

Conclusion

This project work suggests the neural network technique for designing linear phase FIR filter. Based on the various algorithms of neural network we concluded that the designed model of FIR filters using neural network are have better performance than the conventional design method of FIR filter. The ADALINE Neural Network algorithm is also the supervised learning algorithm. Here the concept of minimization of sum of the square errors between the amplitude response of the desired filter and that of the designed by neural network is used. Through the comparison we have seen that the proposed neural network optimization technique gives better result than the design technique of linear phase FIR filters given by authors. The method is not involved in operation of inverse matrix, and the pass-band and stop- band ripples based on the proposed method are less than the method proposed by authors. This shows that the proposed method is effective.

The HNN based approach is an alternative for designing FIR digital filters. The designs based on this algorithm are have fast response and hardware implementation is also done by using analog VLSI technology.

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