DESIGNING of LOW PASS FIR FILTER USING ARTIFICIAL NEURAL NETWORK

Meenal singh[1], Vandana Vikas Thakare [2]

Dept. of Electronics Engineering [1, 2]

Madhav Institute of Technology & Science, Gwalior INDIA [1, 2]

Minalsingh03@gmail.com[1],vandanavt_19@rediffmail.com [2]

***Abstract*: - The present paper investigates an approach to design and analysis of a low pass FIR filter using artificial neural network. The main aim of design is to find out the filter coefficients that define the filter transfer functions. A datasheet of 40 different values of h(n) i.e. coefficient of digital low pass FIR filter are used for filter designing. In this paper feed forward generalized regression method is used for train artificial neural network. A combination of digital signal processing algorithm and neural network is obtained with the help of MATLAB to produce effective algorithm for digital filter design is used in the present work.**

***Key words:* Artificial Neural Network (ANN), Digital Signal Processing (DSP), Finite Impulse Response (FIR).**

I. INTRODUCTION

In signal processing, there are many instances in which input signal to a system come along with lots of unnecessary signal which acts as a noise to the system and can degrade the quality of desired portion. In such condition removal of extra unnecessary signal is required which is obtain by filters. With technological evolution various advance filter designing methods have been developed. A filter is a network that selectively changes amplitude-frequency and/or phase-frequency of a signal in desired manner. Filters are of many types such as low pass filter, high pass filter, band pass filter, and band stop filter. Low pass filter are the one which passes low frequency signal and attenuates signal with frequency higher than the cut off frequency. As at present all the information processing is done digitally so there is a large demand of digital filter because of which from decades lots of work for design digital filter by different methods are being research. One of the ways is to design digital filter using artificial neural network. A digital filter is algorithm implemented in both hard ware and software and operates on digital input signal to produce digital output signal. Digital filter are of two type depending upon response Infinite Impulse Response filter (IIR) and Finite Impulse Response filter (FIR). IIR filters are those filters having internal feedback and may continue to respond indefinitely.FIR filter are those, whose impulse response is of finite duration as it settles to zero in finite time. A general low pass FIR filter is shown in Fig.1. The operation of low pass FIR filter is described by the following equation, which defines the output sequence *y[n]* in terms of its input sequence *x[n]*:

$$y[n] = b_0\, x(n) + b_1\, x(n-1) + \text{----------} + b_n\, x(n-N)$$

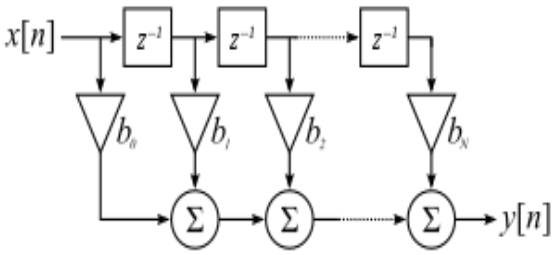

Fig.1 Simple Low Pass FIR Filter

Designing of FIR filter involves complex calculation as by substituting values of pass band attenuation, transition width, pass band ripple, stop band attenuation, sampling frequency method from window method, frequency sampling method or Fourier series method.[1]

Window method is one of the most efficient methods in designing of FIR filter before artificial neural network (ANN), as it gives optimal design better than other methods. Window method have different type of windows like Rectangular window, Kaiser window, Triangular window, Hamming window, Hanning window, Blackman window, Lanczos window and Tukey window. The rectangular window is the simplest window method, equivalent to replacing all but *N* values of a data sequence by zeros, making it appear as though the waveform suddenly turns on and off, The triangular window is the 2nd order *B*-spline window which

can be seen as the convolution of two half-sized rectangular windows, giving it twice the width of the regular windows. The Kaiser, or Kaiser-Bessel, window is a simple approximation of the using Bessel functions.

Previously Kaiser Windows method has been used, but in present paper hamming window method is using for training artificial neural network.

An Artificial Neural Network is an information processing system inspired by the way high dense inter-connected parallel structure of brain process information. ANN have successfully applied to a number of application such as Filtering, Identification, Control, Predication etc among all most common task of ANNs are classification and function approximation. ANN is collection of biological neural network connected in highly simplified structure. The key element of ANN is the novel structure of information processing system. Neural network with their remarkable ability detects trends that are too complex to be noticed. A trained neural network can be thought of as an "expert" in information analyses in range of training. Till now, a lot of results of designing digital filter using ANN have been presented,[1]-[5], to mention a few neural network based model for optimal design of linear phase FIR filter have been introduce by the help of Generalized Brain-State in a Box neural network gives fast but equilibrium point of Lyaponov energy function[2]. A comparison of FIR filter design using Remez exchange algorithm trained by Blackman Window method, frequency sampling method and optimal method shows that the response curve of FIR filter depends on width of transition band [3].

In present paper Generalized Regression Neural Network (GRNN) is being used. Generalized Regression Neural Network (GRNN) is a variation of the radial basis neural networks, which is based on kemel regression networks. GRNN does not require an iterative training process as required in the back propagation network. It approximates any arbitrary function between input and output, gives function estimation directly from the training data. In GRNN as the size of training set increases estimation error approaches to zero.

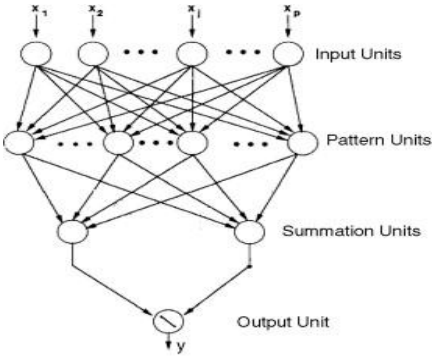

Fig.2 Generalized Regression Neural Network

Fig. 2 shows a Generalized Regression Neural Network. A GRNN consists of four layers: input layer, pattern layer, summation layer and output layer as shown in figure. The number of units in input layer depends on the total number of the observation parameters. . The output layer divides the output of each S-summation neuron by that of each D-summation neuron, yielding the predicted value Y'_i to an unknown input vector x as

$$Y'i = \frac{\sum_{i=1}^{n} yi * \exp - D(x, xi)}{\sum_{i=1}^{n} exp - D\ (x, xi)}$$

$$D(x, xi) = \sum_{k=1}^{m} \left(\frac{xi - xik}{\sigma}\right)^2$$

II. PRINCIPLE

In previous works Kaiser Window method because of presence of ripple parameter beta has been used. In Kaiser Window, the side lobe level can be controlled with respect to the main lobe peak by varying a parameter, α. The width of main lobe can be varied by adjusting the length of the filter [6]. The Kaiser Window function is given by:

$$w(n) = \frac{I0\left(\pi\alpha\sqrt{1 - \left(\frac{2n}{N-1} - 1\right)\text{^}2}\right)}{I0(\pi\alpha)} \quad (1)$$

$$\beta \triangleq \pi\alpha \quad (2)$$

But the drawback associated with Kaiser Window method is that, the Kaiser Window method does not minimize the maximum (nearest) side lobe of signal and that is why in output nearest side lobe also come in existence.

In the presented work Hamming Window method is use, Hamming Window method optimized to minimize the maximum (nearest) side lobe , giving it a height of about one-fifth that of other window .

$$w(n) = \alpha - \beta \cos\left(\frac{2\pi n}{N-1}\right) \quad (3)$$

with

$$\alpha = 0.54\ , \beta = 1 - \alpha = 0.46 \quad (4)$$

The value of α and β are approximately constant which cancel the first side lob of signal by placing a zero at nearest frequency.

III. PROCEDURE

A. *Designing*

1) *Filter Specification:*

In the first step, type of filter is specified for example Low Pass Filter, the desired amplitude. In presented paper Low Pass FIR Filter with normalized cut off frequency between 0 to 1 Hz is been design.

2) *Coefficient Calculation:*

In the next step, determination of filter transfer function coefficient is done. In presented paper filter coefficient is obtain by FDA TOOL of MATLAB using Hamming Window.

3) *Realization:*

In the next step transfer function coefficient obtain above is converted into suitable filter network.

4) *Analysis of finite word length:*

In this step training of ANN is done by input some values of filter coefficient calculated in above step. In this paper a data sheet of 40 values of h(n) i.e. coefficient of filter is made out of which 36 values are use for training of Generalized Regression Neural Network (GRNN).

5) *Implementation:*

In the last stage, after training simulation (testing) of network is done by calculating output in the training range.

B. *Analysis*

The network has been trained using Multilayer Perceptron in which Generalized Regression Neural Network (GRNN) has been used to design Low Pass FIR Filter.

In Fig.3 an error graph between hamming window output and ANN output is shown.

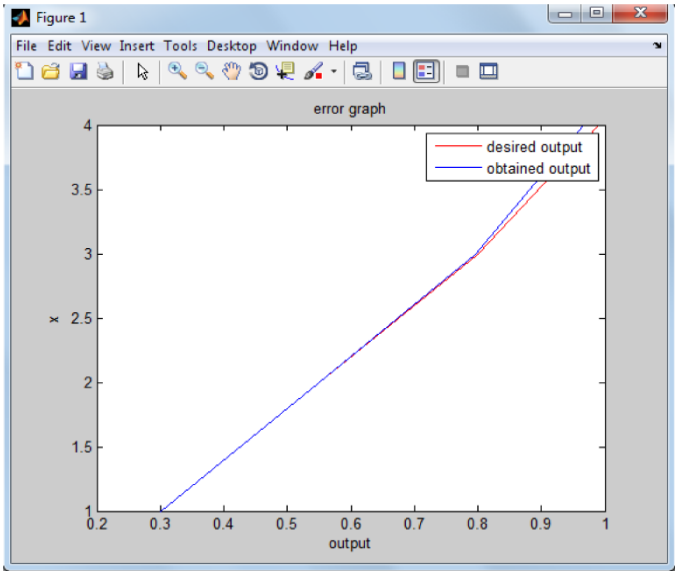

Fig.3 Error Graph

Table 1 shows hamming window versus ANN results having variable parameter normalized cut-off frequency (w_c) ranging from 0 to 1 Hz and fixed variable specify order is set to 10.

Table 1

Hamming window versus ANN

h(n) filter transfer function coefficition	**Hamming Window Method**	**Artificial Neural Network**	**Error**
h(0)	0.30	0.30037	0.00037
h(1)	0.55	0.54972	0.00028
h(2)	0.80	0.78963	0.01037
h(3)	0.99	0.95606	0.03394

IV. CONCLUSION

Artificial Neural Network is effective method of design of Low Pass Fir Filter. FIR Filter can also be designed by Fourier series method; Frequency sampling method and Window method, but the drawback of these methods is for each unknown variable the filter coefficients have to calculate. In case of ANN the train network can calculate any unknown filter coefficient within the training range of network.

If error graph between ANN output obtained by using Generalized Regression and Hamming Window output is drawn there is almost negligible error occur, the percentage error is approximately equal to 0.05%.

And hamming window provides optimized to minimize the maximum (nearest) side lobe.

REFERENCES

[1] Sheenu Thapar, "A Low Pass FIR Filter Design Using Genetic Algorithm Based Artificial Neural Network "International Journal of Computer Technology and Electronics Engineering (IJCTEE) Volume 2, Issue 4, August 2012

[2]S. Abbas Hussein and Farad Farokhi"An Optimum Design of Linear Phase FIR Filters by the Generalized Brain-State-in-a-Box Neural Network Model" 2009 IEEE Symposium on Industrial Electronics and Applications (ISIEA 2009), October 4-6, 2009, Kuala Lumpur, Malaysia

[3]S. M. Shamus Alma, " Performance Analysis of FIR Filter Design by Using Optimal, Blackman Window and Frequency Sampling Methods "International Journal of Electrical & Computer Sciences " IJECS-IJENS Vol:10 , No: 01 (13-18)

[4]Amanpreet Kaur**, "**Design of FIR Filter Using Particle Swarm Optimization Algorithm for Audio Processing " International Journal of Computer Science and Network (IJCSN) Volume 1, Issue 4, August 2012.

[5] Harpreet Kaur and Balwinder Dhaliwal," Design of Low Pass FIR Filter Using Artificial Neural Network," in *International Journal of Information and Electronics Engineering, Vol. 3, No. 2, March 2013.*

[6]S N Sivanandam ,S Sumathi and S N Deepa, *Introduction To Neural Network using MATLAB 6.0,*Tata McGraw-Hill Companies, New Delhi,2008.

[8] S. Haykins, *Neural Networks–A Comprehensive Foundation*, Prentice – Hall of India Private Limited, New Delhi, 2003.

[9] J. G. Proakis and D. G. Manolakis, *Digital Signal Processing – Principle, Algorithms and Applications*, Prentice –Hall of India, New Delhi, 2000.

