Design A Rectangular Window Based Digital Filter Using Layer Recurrent Method

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***Abstract*—in this paper low pass filter has been design using FIR rectangular window technique. The coefficient of this filter calculated at frequency range from 0.05 to 0.95. the collection of 17 data values out of 19 data has been used for trining of neural network using layer recurrent neural network algorithm. Simulation of this neural network done using remained two test data the accuracy of this neural network approximate near to data value collected from fda tool.**

***Index Terms*—FIR,algorithm,fda tool.**

I. INTRODUCTION

Digital filters are a main element of *Digital Signal Processing* (DSP). In fact, their surprising performance is one of the explanation reasons that DSP has become so admired. Filter design is the procedure of develop an algorithm or other transformation of input sequences to obtain desired output sequence . Filter design method can be described as an optimization difficulty where each condition contributes with a term to an error function which should be minimized. There are of two types of Digital Filters, Finite Impulse Response (FIR) filters and Infinite Impulse Response (IIR) filters. *Infinite impulse response(IIR)*, filters are the digital complement to analog filters. Such a filter contain internal state, and the production and the next internal state are determine by a linear arrangement of the previous inputs and outputs . In theory, the impulse response of such a filter never die out completely, though in observe, this is not true given the fixed resolution of computer arithmetic. A digital filter is a mathematical algorithm implement in hardware and software that operate on digital input signal to create a digital output signal for the point of achieve a filter objective. describe filters are synthesize by cascading essentials from a records of computationally simple and some case very computationally proficient, primal filter. A simplify block diagram of digital filter, with analog input and output signals is shown in Fig 1

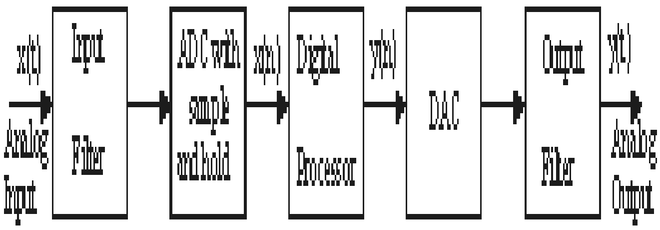

Figure 1- Block Diagram of Digital filter

Artificial Neural Network

Neural network methods have been predictable as a powerful tool for microwave designs and other problems. Different methods can be developed combining NN and optimization method for quicker and correct filter solution. Applications of neural network to prototype classification have been widely studied in the long-ago years. Several kinds of neural-network architecture as well as multilayer perception (MLP) neural network, radial basis function (RBF) neural network, self-organizing map (SOM) neural network, and probabilistic neural network (PNN) have been projected. Neural networks have the capacity to model multidimensional nonlinear relationships. The evaluation from input to output of a train neural network model is also extremely fast. These features make neural networks a useful option for device modeling where a mathematical model is not obtainable or repetitive electromagnetic (EM) simulate ion is required. Once a model is developed, it can be used again a gain. This avoids repete EM simulate ion where a simple change in the objective dimension requires a complete residual ion of the EM structure Artificial Neural Networks are computing system made up of several number of very highly interrelated processing elements, which process informant ion by their dynamic state response to outside inputs. Since the task of ANNs is to progression information, they are used mostly in fields interrelated with it. There are a wide diversity of ANNs that are used to representation real neural networks, and study action and control in nature and machines, but also there are ANNs which are use for engineering purpose, such as pattern recognition, forecasting and compression of data. Artificial neural networks are amongst the most recent signal-processing technologies in the engineer's tools. The field is extremely interdisciplinary, but our approach will limit the view to the engineering point of view. In engineering, neural networks provide two main functions: pattern classifiers and nonlinear adaptive filters. We will present a brief summary of the theory, learning rules, and applications of the nearly all important neural network models. Definite ions and method of Computation An Artificial Neural Network is an adaptive, often nonlinear system that learns to achieve a function from data. A Multilayer network with l layer of unit shown in figure 2.

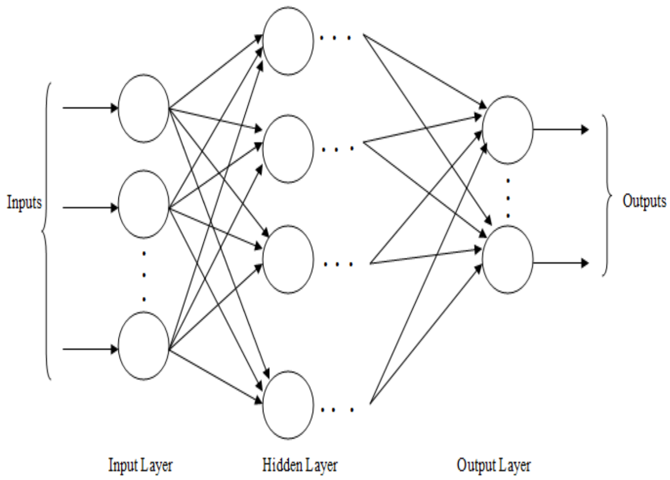

Figure 2- A Multilayer Network with l layers of Unit

Design FIR Filter by Window Method

The window method want minimum amount of computational exertion; so window method is easy to execute. For the given window, the maximum amplitude of ripple in the filter response is set. Thus the stop band attenuation is fixed in the given window, but there are some disadvantage also of this method . The design of fir filter is not flexible. The frequency response of fir filter shows the difficulty of spectrum of window function & desired frequency response because of this the pass band & stop band edge frequency cannot be explicitly specified. In this work we use rectangular window method.

Formulation of Problem

The plan of this paper is to estimate the cut off frequency of any given coefficients of fir filter and increase the accuracy of result from previous work. Accuracy is determined by com-paring the result from *fdatool* and *nntool*. For training purpose we use input output dataset derived from *fdatool*, and for testing purpose we use a test input and simulate it using *nntool*.

Methodology

By this methodology we employ rectangular window technique for filter designing and Layer Recurrent neural network for training purpose.

Step 1

Low pass fir filter designed through *fdatool*. The order of filter is 19. We employ the cut of frequency ranges from 0 to 1 and set the rate of fc=0.05 and design the filter. do again the same process for value of fc from 0.1 to 1. So this gives the 19 dataset of input and output data. beyond these 19 dataset we use 17 used for training and 2 used for testing. Here input is h(n) and output is fc. The screen shot of first step is given below in Figure 3.

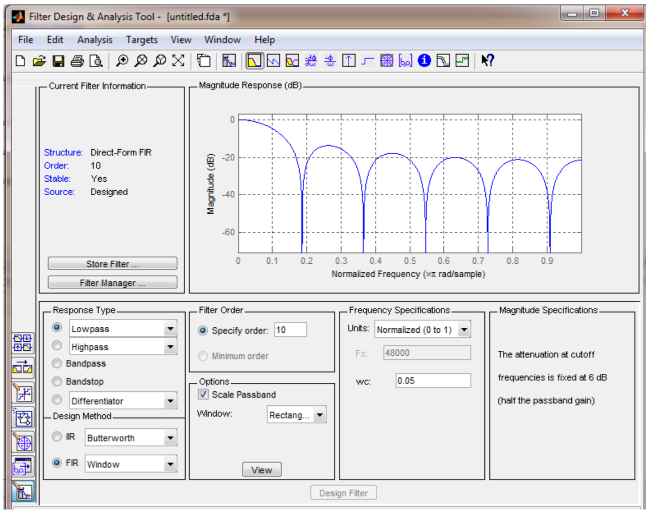

Figure 3- Filter Designing by fda Tool

Step 2

By this step we design the recurrent layer neural network model by *nntool* . Training is done by layer recurrent method and spread constant is set to 0.1. After training, create the network by testing input, and the simulation effect shown in Figure 4.

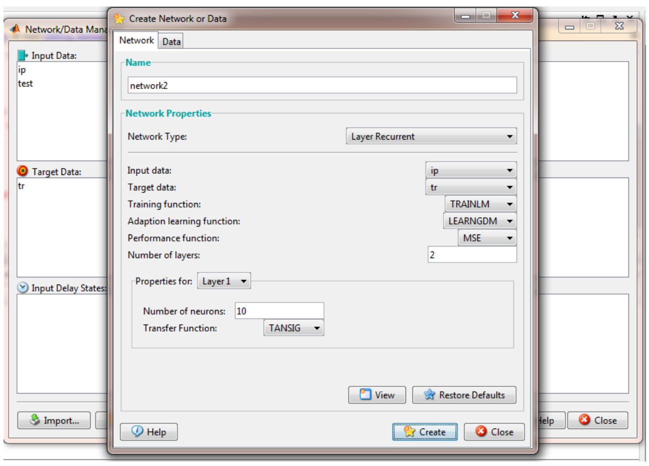

Figure 4 – Creating Network by nn tool.

Table 1. Result from *fdatool* (for Train Input)

h(n) (Test Input)											Cut off frequency (Target)
h(0)	h(1)	h(2)	h(3)	h(4)	h(5)	h(6)	h(7)	h(8)	h(9)	h(10)	Fc
0.085278	0.088609	0.091253	0.093169	0.094331	0.09472	0.094331	0.093169	0.091253	0.088609	0.085278	0.05
0.068147	0.081014	0.091886	0.100139	0.105292	0.107044	0.105292	0.100139	0.091886	0.081014	0.068147	0.1
0.039228	0.065953	0.091324	0.112206	0.125931	0.130716	0.125931	0.112206	0.091324	0.065953	0.039228	0.15
6.65E-18	0.0399	0.086079	0.129119	0.1596	0.170605	0.1596	0.129119	0.086079	0.0399	6.65E-18	0.2
-0.04174	9.04E-18	0.069566	0.147572	0.208699	0.231806	0.208699	0.147572	0.069566	9.04E-18	-0.04174	0.25
-0.06614	-0.0486	0.034066	0.157268	0.26756	0.311698	0.26756	0.157268	0.034066	-0.0486	-0.06614	0.3
-0.05001	-0.08408	-0.01844	0.143041	0.315074	0.388821	0.315074	0.143041	-0.01844	-0.08408	-0.05001	0.35
0.06053	-1.85E-17	-0.10088	1.85E-17	0.302652	0.475404	0.302652	1.85E-17	-0.10088	-1.85E-17	0.06053	0.5
0.041878	0.043514	-0.08795	-0.04575	0.292478	0.511665	0.292478	-0.04575	-0.08795	0.043514	0.041878	0.55
2.24E-17	0.072424	-0.05968	-0.08952	0.289695	0.574164	0.289695	-0.08952	-0.05968	0.072424	2.24E-17	0.6
-0.04557	0.076613	-0.0168	-0.13034	0.287104	0.657994	0.287104	-0.13034	-0.0168	0.076613	-0.04557	0.65
-0.06743	0.049544	0.034729	-0.16033	0.272764	0.741442	0.272764	-0.16033	0.034729	0.049544	-0.06743	0.7
-0.04779	3.10E-17	0.079657	-0.16898	0.238971	0.796289	0.238971	-0.16898	0.079657	3.10E-17	-0.04779	0.75
-3.18E-17	-0.04774	0.102997	-0.1545	0.190968	0.816546	0.190968	-0.1545	0.102997	-0.04774	-3.18E-17	0.8
0.043715	-0.0735	0.101768	-0.12504	0.140333	0.825434	0.140333	-0.12504	0.101768	-0.0735	0.043715	0.85
0.060214	-0.07158	0.08119	-0.08848	0.093035	0.851252	0.093035	-0.08848	0.08119	-0.07158	0.060214	0.9
0.043117	-0.0448	0.046138	-0.04711	0.047694	0.909919	0.047694	-0.04711	0.046138	-0.0448	0.043117	0.95

Table 2. Result from *fdatool* (for Test Input)

h(n) (Test Input)											Cut off frequency (Output)
h(0)	h(1)	h(2)	h(3)	h(4)	h(5)	h(6)	h(7)	h(8)	h(9)	h(10)	Fc
-1.70E-17	-0.08258	-0.06805	0.102076	0.330325	0.436461	0.330325	0.102076	-0.06805	-0.08258	-1.70E-17	**0.40**
0.045722	-0.04751	-0.09602	0.049953	0.319324	0.457061	0.319324	0.049953	-0.09602	-0.04751	0.045722	**0.45**

Table 3.Simulation Result from *nntool*(for Test Input)

h(n) (Test Input)											Cut off frequency (Output)
h(0)	h(1)	h(2)	h(3)	h(4)	h(5)	h(6)	h(7)	h(8)	h(9)	h(10)	Fc
-1.70E-17	-0.08258	-0.06805	0.102076	0.330325	0.436461	0.330325	0.102076	-0.06805	-0.08258	-1.70E-17	0.48484
0.045722	-0.04751	-0.09602	0.049953	0.319324	0.457061	0.319324	0.049953	-0.09602	-0.04751	0.045722	0.50571

Results and Discussion

In the above experiment, According the Table 2: (Result from *fdatool*) For the test input h(n), the output fc is 0.45 & 0.50. this result is deduce from filter designing tool. According to the Table 3: (Simulation result from *nntool*) the output for the same test input h(n) is 0.48484 & 05071. This result is taken from neural network tool. So the results from *nntool* and *fda-tool* are nearly same, and by this process we can easily estimate the cut off frequency of any fir filter.

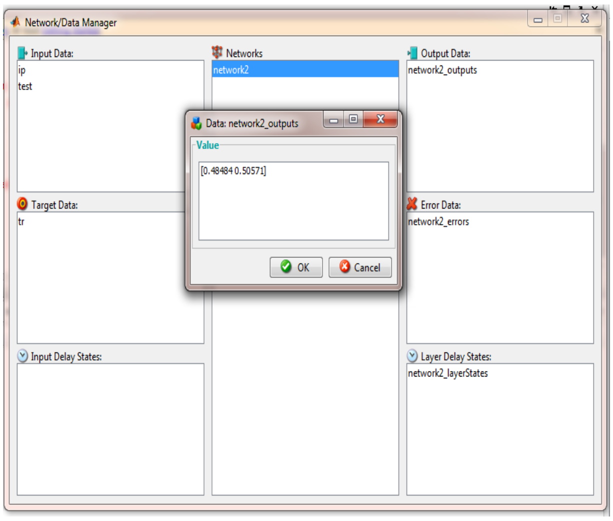

Figure-5 Result of Simulation Process

Conclusion

From this experiment we estimate the cut off frequency and other parameter from filter coefficient by the help of Layer Recurrent, and it is quite simple method than complex calculative window method. The above figures show that results come from rectangular window method and artificial neural network is almost same. For the filter designing purpose This Layer Recurrent train-ing algorithm is much better than other training algorithm like MLP, RBF *etc*. In the previous work, when MLP is used as a training algorithm, result is about 93% accurate. By the using of Layer Recurrent algorithm, the accuracy of result is almost 98%. So there is increment of 5% in accuracy, which is very effective.

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