Optimized and Design of 4th Order Length 28 Digital Differentiator Using Genetic Algorithm

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Abstract:
Latest in image processing, transport salesman problème and VLSI genetic algorithmes plays vital roll.Digital Differentiator is a important signal processing tool. It is found in many applications, from low frequency biomedical equipment to high frequency radars. New developing fields such as touch screen tablets and online signature verification also has digital differentiators as basic building block. In this paper the design of second order digital differentiator is presented using one of the optimization techniques Genetic Algorithm. In this paper we have designed forth order digital differentiator of filter length twenty eight and Many methods have been developed to design all types of differentiators but there is still scope of improvement in terms of parameters optimization.

Keywords: GA, FIR, DDs, Cromosomess Mutation

I. INTRODUCTION

In our research we have used genetic algorithm which is most optimized method to design the digital differentiator. The usual form of GA was described by Goldberg [3]. A chromosome is real-valued instead of binary bit strings. During each generation, the chromosomes are evaluated with some measures of "fitness". According to the "fitness" values, a new generation is formed by selecting some of the parents and off spring, and rejecting others so as to keep the population size constant. After several generations, the algorithms converge to the best chromosome, which represents the optimal solution to the problem. By using this we have designed DD of length thirty two of order four. The rate of liquid flow in a tank (which may be part of a chemical plant) is estimated from the derivative of the measured liquid level. In biomedical investigations, it is often necessary to obtain the first and higher order derivatives of the biomedical data, especially at low frequency ranges. For example in QRS complex detection in ECG. The genetic algorithm to minimize relative error in the response of DDs can be developed as it is observed that not much published work is available on relative error optimization of DDs, especially with respect to higher order DDs.

The design flow of genetic algorithm is shown as:
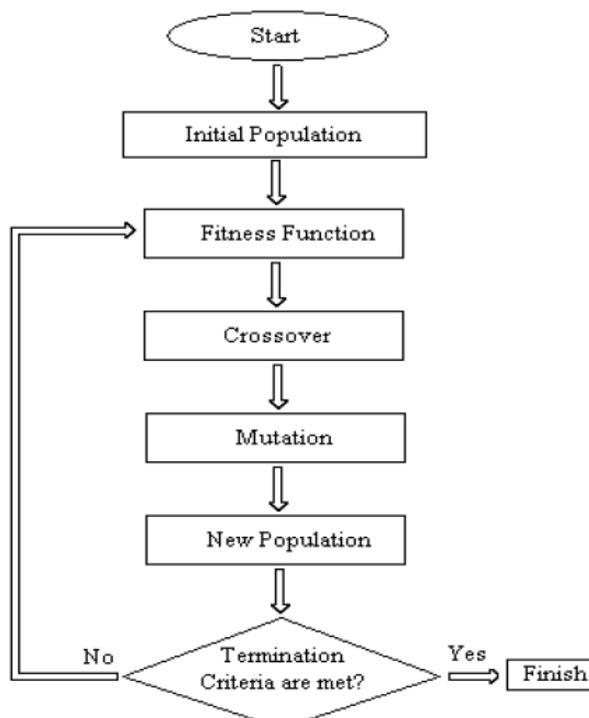
The different operations involved in Genetic algorithms are:

- **SELECTION**

The first step consists in selecting individuals for reproduction. This selection is done randomly with a probability depending on the relative fitness of the individuals so that best ones are often chosen for reproduction than poor ones.

- **REPRODUCTION**

In the second step, offspring are bred by the selected individuals. For generating new chromosomes, the algorithm can use both recombination and mutations.

- **EVALUATION**

Then the fitness of the new chromosomes is evaluated.

- **REPLACEMENT**

During the last step, individuals from the old population are killed and replaced by the new ones In the basic Genetic Algorithm, to improve the fitness value of the chromosomes (represents a possible FIR filter) basic error functions are used. The chromosomes which have higher fitness values represent the better solutions.

Basic FIR filter is characterized by

$$y(n) = \sum_{k=0}^{N-1} z(k)x(n-k)$$

and the transfer function of the system is given by

$$Z(z) = \sum_{k=0}^{N-1} Z(k)z^{-k}$$

Where h(k) is the impulse response coefficients of filter, N is the filter length (number of coefficients). FIR filters can have exactly linear phase response.
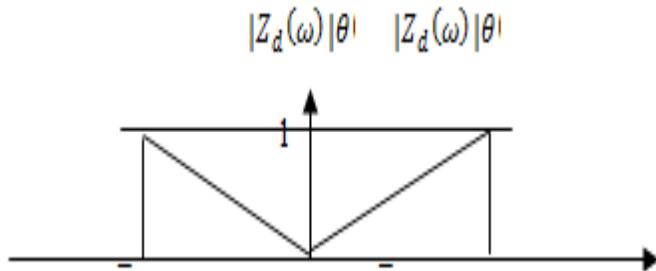An ideal differentiator has the frequency response as defined below:

$$Z_d(\omega) = i\omega \qquad -\pi \leq \omega \leq \pi$$
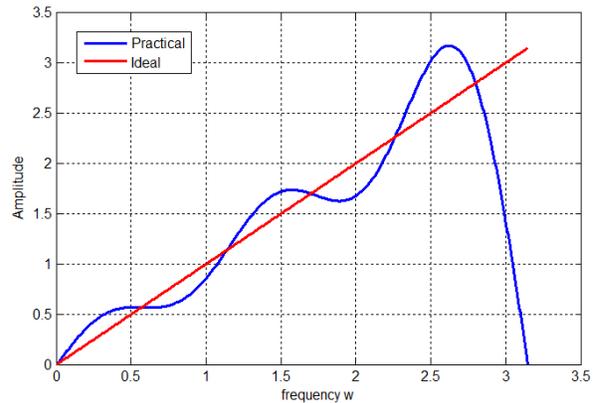
Hence, the magnitude and phase responses are

$$|Z_d(\omega)| = |\omega| \qquad -\pi \leq \omega \leq \pi$$

and

$$\theta(\omega) = \angle Z_d(\omega) = \begin{cases} \frac{\pi}{2}, & \omega > \\ 0 & \omega = \\ -\frac{\pi}{2}, & \omega . \end{cases}$$

The corresponding sketch of magnitude and phase responses of an ideal differentiator is shown below:

$$|Z_d(\omega)||\theta| \qquad |Z_d(\omega)||\theta|$$

The amplitude and frequency response of ideal digital differentiator is given by

The unit sample response of is obtained by taking inverse DTFT of as:

$$Z_d(n) = \frac{1}{2\pi} \int_{-\pi}^{\pi} Z_d(\omega) e^{i\omega n} \, d\omega$$
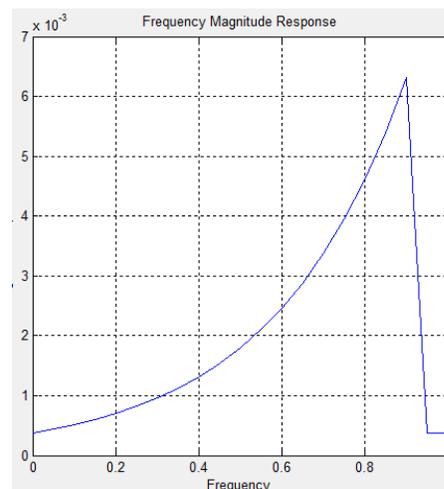
We can design digital differentiator of any order. Higher order digital differentiators have received considerable importance in some applications such as calculation of geometric moments and biological signal processing.

Wp=0.92π; k=4; N=28;
;

Frequency Magnitude Response

Frequency | Magnitude Response|

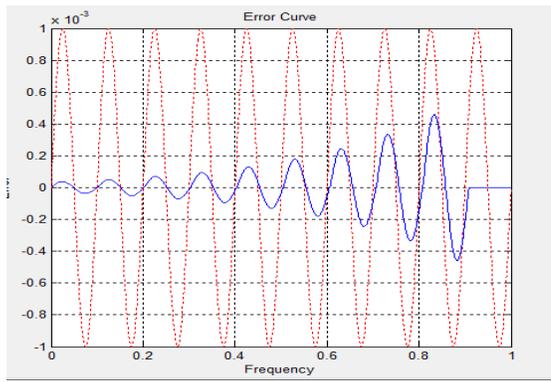| Frequency	Magnitude Response
0	0.000373903
0.05	0.0004375
0.1	0.000511914
0.15	0.000598984
0.2	0.000700865
0.25	0.000820074
0.3	0.000959559
0.35	0.00112277
0.4	0.00131374
0.45	0.00153719
0.5	0.00179865
0.55	0.00210458
0.6	0.00246255
0.65	0.0028814
0.7	0.00337149
0.75	0.00394495

0.8	0.00461594
0.85	0.00540106
0.9	0.00631972
0.95	0.000373903
1	0.000373903

Error Curve

Frequency | Error

0	0
0	0
0.01	2.18697e-005
0.02	3.53859e-005
0.03	3.53859e-005
0.04	2.18697e-005
0.05	4.55653e-021
0.06	-2.18697e-005
0.07	-3.53859e-005
0.08	-3.53859e-005
0.09	-2.18697e-005
0.1	-9.11306e-021
0.11	2.72952e-005
0.12	4.7363e-005
0.13	4.93399e-005
0.14	3.24705e-005
0.15	3.19856e-006
0.16	-2.72952e-005
0.17	-4.7363e-005
0.18	-4.93399e-005
0.19	-3.24705e-005
0.2	-3.19856e-006
0.21	3.35988e-005
0.22	6.31051e-005
0.23	6.85074e-005
0.24	4.77422e-005
0.25	8.74108e-006
0.26	-3.35988e-005
0.27	-6.31051e-005
0.28	-6.85074e-005
0.29	-4.77422e-005
0.3	-8.74108e-006
0.31	4.06556e-005
0.32	8.36744e-005
0.33	9.47323e-005
0.34	6.96058e-005
0.35	1.78922e-005
0.36	-4.06556e-005
0.37	-8.36744e-005
0.38	-9.47323e-005
0.39	-6.96058e-005
0.4	-1.78922e-005
0.41	4.81248e-005
0.42	0.000110379
0.43	0.000130472
0.44	0.000100729
0.45	3.25111e-005
0.46	-4.81248e-005
0.47	-0.000110379
0.48	-0.000130472
0.49	-0.000100729
0.5	-3.25111e-005
0.51	5.53088e-005
0.52	0.0001448
0.53	0.000178983
0.54	0.0001448
0.55	5.53088e-005
0.56	-5.53088e-005
0.57	-0.0001448
0.58	-0.000178983
0.59	-0.0001448
0.6	-5.53088e-005
0.61	6.09407e-005
0.62	0.000188812
0.63	0.000244563
0.64	0.0002069
0.65	9.02078e-005
0.66	-6.09407e-005
0.67	-0.000188812
0.68	-0.000244563
0.69	-0.0002069
0.7	-9.02078e-005
0.71	6.28656e-005
0.72	0.000244566
0.73	0.00033285
0.74	0.000293997
0.75	0.000142847
0.76	-6.28656e-005
0.77	-0.000244566
0.78	-0.00033285
0.79	-0.000293997
0.8	-0.000142847
0.81	5.75693e-005
0.82	0.000314433
0.83	0.000451194
0.84	0.000415614
0.85	0.000221284
0.86	-5.75693e-005
0.87	-0.000314433
0.88	-0.000451194
0.89	-0.000415614
0.9	-0.000221284
0.91	0
0.92	0
0.93	0
0.94	0
0.95	0
0.96	-0
0.97	-0
0.98	-0
0.99	-0
1	-0

Error Curve

II. CONCLUSION

In this paper we have used Genetic algorithm technique one of the best techniques to design the digital *differentiator* *Pass band* $p=0..92*\pi;$ of order four and length twenty eight .And we have observed that the error is minimum compare to all other techniques. The future scope of this paper is to compare the same design optimization technique of higher order and different length to different optimization technique We found many applications of differentiators and mentioned in this paper. The future scope of this paper is to compare the same design using different optimization techniques

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