Review Paper of Design of Digital Filter using Particle Swarm Optimization

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ABSTRACT: Digital filters play an important role in digital communication. it is a basic building block in any digital signal processing (DSP) system. Digital filter is a system that uses the discrete time signal as input and produced a discrete time output signal to achieve a filter objective. In the last decades, so many optimization techniques are developed for the designing of the digital filter. These techniques give better magnitude response and phase response of the filter. in this review paper, we analyzed the various optimization methods and approaches such as particle swarm optimization(PSO) and gravitational search algorithm (GSA) for optimal digital filter design.

Keywords: Digital filter, PSO, GSA, optimization

1.INTRODUCTION:

In digital signal processing systems signals are the important elements. The signal is a physical quantity that changes with respect to other independent variables. These independent variables are discrete time, discrete frequency, or any sequence of numbers or symbols. when this signal is transmitted through a channel some noise and other signal are mixed with the signal. to extract or regain the actual information present in the signal, a device is used called a filter. The filter is an electrical network which removes the unwanted parts of the signal or extracts the useful parts of the signal. Digital filter is a mathematical algorithm that implemented using the combination of hardware and software to operate on a digital input to produce a digital output. [2] Digital filters are used in a wide variety of applications like signal processing, telecommunication, control systems and many more. Digital filter has a linear phase response and used on low frequencies.

On the basis of impulse responses digital filters are of two kinds:

- Finite impulse response (FIR) filter
- Infinite impulse response (IIR) filters

FIR filter is the nonrecursive filter because they do not require any feedback. Due to this, the impulse response of FIR filter remains finite. IIR filter has the impulse response for an infinite duration. IIR filter is known as recursive in nature they required feedback signal[2].FIR has some advantage over IIR filter. it has linear phase response and FIR filter are always stable. The method of FIR filter is generally linear.

2.PARTICLE SWRAM OPTIMIZATION (PSO) :

PSO is a population-based stochastic optimization technique developed by Dr. Eberhart and Dr. Kennedy in 1995, inspired by social behavior of bird flocking or fish schooling[14]. PSO is simple and fast. It requires less storage and easy in programming. In this algorithm, a particle represents the bird and each particle gives a solution. This algorithm is initiated with some randomly generated solutions that are called the particles. Each particle has information of speed that guides birds flight.[4]

Every particle has its own best solution(P_{best}) and group best solution (G_{best}). Particles tries to modify its position using the following information. In PSO position and velocity of particles is represented as

$X_i=(X_{i1}, X_{i2}, X_{i3} \dots \dots \dots \dots X_{iD})$ (1)

$V_i=(V_{i1}, V_{i2}, V_{i3} \dots \dots \dots \dots V_{iD})$ (2)

the velocity of the particle is modified using (3) equation

$$V_i^{n+1} = w * iV_{id} + C_1 * rand1 * (P_{best} - X_{iD}) + C_1 * rand2 * (G_{best} - X_i) \quad (3)$$

here V_i^n is the velocity of the particle of vector i^{th} at k^{th} iteration w is the weight factor C_1 and C_2 are the constants rand1 and rand2 are random values in the range of [0,1]. In the equation (3), the first term is the previous velocity of the particle vector and second, third terms are used to change the velocity of particle vector. Parameter w is the inertia weight in the nth iteration.[3]

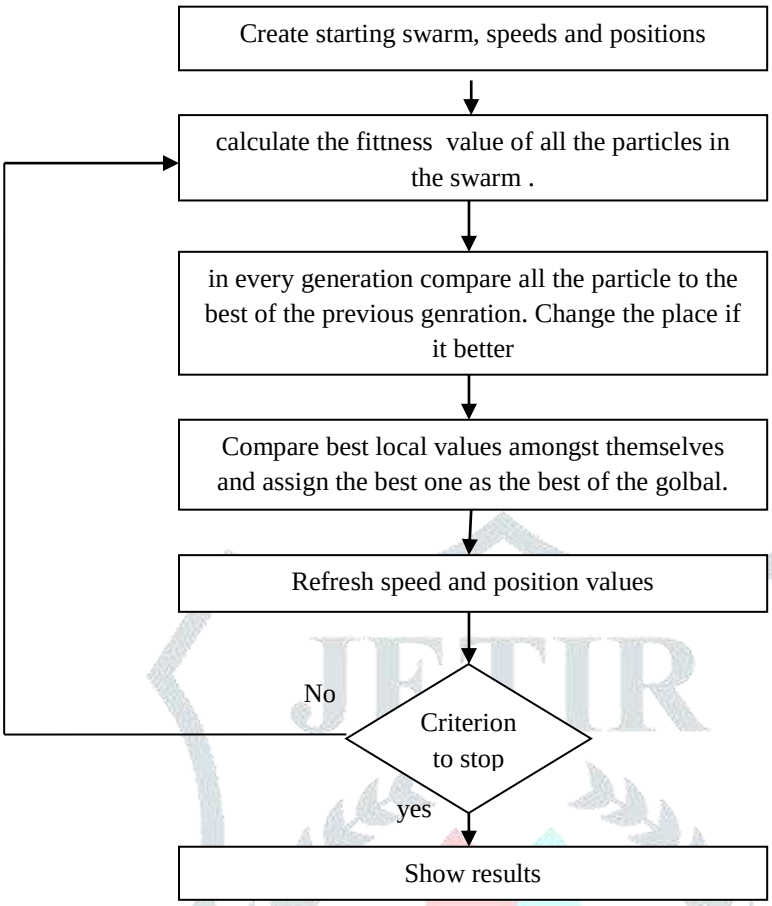

Figure 1 Data flow diagram of the PSO[4]

3.LITERATURE SURVEY

F.SORBET et. al [4] this paper represented the design of digital infinite impulse response filter using particle swarm optimization algorithm the results are obtained by the pso in the shortest time due to high convergence speed.PSO explored the search space locally as well as globally and uses them in the mathematical formulas of velocity and the particle position.

Nikhil_Agrawal et. al [5]In this paper, a new design method based on fractional derivative (FD) is proposed for designing digital stable infinite impulse response filters with a nearly linear-phase response. FD is employed to improve the frequency response of the filter at some reference point in the passband. Optimal values of FD constraints and reference points in passband are determined by minimizing the sum of error in passband and stopband of an IIR filter.

N.Agarwal et al.[6] had used the cuckoo search algorithm for the designing of the IIR filter with controlled ripple in passband and stopband. using this technique high stopband attenuation is achieved and passband error and stopband error is also increased. the filter designed using this technique is stable and survive under truncation and quantization.

Himanshu Gupta et. al [7] this paper had use an improved version of PSO called Restart PSO for the design of linear phase low pass FIR filter. PSO is a population-based metaheuristic algorithm widely. Optimization Algorithms are successfully used in solving multimodal optimization problem where the traditional gradient-based methods fail.

A. Deep Borah et al. [8] had introduced a paper in which they work on craziness based particle Swarm optimization algorithm and analyzed optimized output to make a comparative study of the conventional PSO techniques. This technique gave the best capability to converge to global optimum with a narrow transition width.

Prabhjot Kaur et. al [9]This paper presented an evolutionary algorithm for the design of digital FIR filter. Particle swarm optimization and differential evolution (DE) algorithms have been applied. The comparison has been done on the basis of magnitude error, ripple magnitudes of both pass band and stop band and maximum stop band attenuation

A. Kaur et al. [10] have stated in their paper that the traditional method of designing suffer from the problem of inefficient frequency response and also need ADC. This paper gave evolutionary computation technique i.e.PSO for the design of high pass filter. this method gave an easier implementation and fast convergence speed**.**

Xi1 Yuanhai[11] this paper stated an Improved Particle Swarm Optimization algorithm is introduced. Compared with conventional PSO, a new inertia weight mechanism is used to ensure the coverage and convergence at a better extent, considering the suboptimal solutions generated by conventional PSO when dealing with complex problems with lots of local minima.

Sangeeta Mondal et. al[12] This paper represented an optimal design of linear phase digital high pass FIR filter using Novel Particle Swarm Optimization (NPSO). NPSO is an improved PSO that proposes a new definition for the velocity vector and swarm updating and hence the solution quality is improved. The inertia weight has been modified in the PSO to enhance its search capability that leads to a higher probability of obtaining the global optimal solution.

Saptarshi Mukherjee et. al [13] This paper presented a novel and accurate method for designing linear phase digital low pass FIR filters by using nonlinear stochastic global optimization based on PSO. The conventional gradient-based optimization techniques are not efficient for digital filter design. in this paper Genetic algorithm, PSO, improved particle swarm optimization (IPSO) has been used for the design of linear phase low pass FIR filter.

4.CONCLUSION

Many traditional methods are there that are used for the designing of the digital filter to obtain an optimal solution. Many authors have proposed techniques to get the accurate coefficient in less computational time. The exact frequency response of IIR filter can be obtained by making use of various optimization algorithms like GA, and PSO etc. This paper presents a review of filter designing using PSO. Many authors have proposed different PSO techniques and proved that PSO is a very efficient, reliable and evolutionary design technique for IIR filter design.

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