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Optimization frequency response of saw filter using Particle swarm optimization

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Abstract-Surface Acoustic Wave filter, a semiconductor device that is used to filter out desired frequencies. Widely used in mobile phones to filter both RF and IF frequencies, a SAW filter uses the piezoelectric effect to turn the input signal into vibrations that are turned back into electrical signals in the desired frequency range. The frequency response characteristics of SAW filters are governed primarily by their geometrical structures, i.e., the configurations of IDTs and reflectors arranged on piezoelectric substrates. However, even if the problem, structural design of SAW filters is formulated as an optimization most design techniques have relied on local optimization methods.
Key words: - SAW Filter, particle swarm optimization.

1. Introduction

Surface Acoustic Wave (SAW) filter is a semiconductor device used to filter out desired frequencies, widely used in mobile phones both for RF and IF frequencies. A SAW filter uses the piezoelectric effect to turn the input signal into vibrations that are turned back into electrical signals in the desired frequency range. The SAW filters are electromechanical devices used in wide range of radio frequency applications providing frequency control, frequency selection and signal processing capabilities their performance is based on piezoelectric characteristics of a substrate in which the electric signal is converted into mechanical one and back again to the electrical domain at the output. After propagating through the piezoelectric element the output is recombined to produce a direct analogue implementation of finite impulse response filter Surface acoustic wave (SAW) filters have been widely used for many applications in recent communication systems [1, 2]. Starting from intermediate-frequency (IF) SAW filters for TVs, radiofrequency (RF) SAW filters are currently available for mobile, wireless and personal communication systems such as cellular phones and personal data assistants (PDAs). The frequency response characteristics of SAW filters are governed primarily by their geometrical structures, i.e., the configurations of
IDTs and reflectors arranged on piezoelectric substrates. For realizing a desirable band pass filter, several computer-aided design approaches have been reported in the [1, 2]. The structural design of SAW filters is formulated as an optimization problem and mostly classical optimization methods have been used to solve them.

2. SAW FILTER

A surface acoustic wave (SAW) is a type of mechanical wave motion which travels along the surface of a solid material. The wave was discovered in 1885 by Lord Rayleigh, and is often named after him. These days, these acoustic waves are often used in electronic devices. At first sight it seems odd to use an acousticwave for an electronicapplication, but acoustic waves have some particular properties that make them very attractive for specialized purposes. And they are not unfamiliar -many wristwatches have a quartz crystal used for accurate frequency generation, and this is an acoustic resonator though it uses bulk acoustic waves rather than surface waves. As the wave passes, each atom of the material traces out an elliptical path, repeating the path for each cycle of the wave motion. The atoms move by smaller amounts as one looks farther into the depth, away from the surface. Thus, the wave is guided along the surface. In the simplest case (an isotropic material), the atoms move in the so-called saw digital plane, i.e. the plane which includes the surface normal and the propagation direction.

3. PARTICLE SWARM OPTIMIZATION

The PSO algorithm is an adaptive algorithm based on a social-psychological metaphor; a population of individuals (referred to as particles)adapts by returning stochastically toward previously successful regions. Particle Swarm has two primary operators: Velocity update and Position update. Duringeach generation each particle is accelerated toward the particles previous best positionand the global best position. The new velocity value is then used to calculatethe next position of the particle in the search space. The particle swarm algorithm is used here in terms of social cognitive behavior. It is widely used for problem solving method in engineering. In PSO, each potential solution is assigned a randomized velocity, are "flown" through the problem space. Each particle adjusts its flying according to its own flying experience and its companions' flying experience. The ith particle is represented as X_i =

($x_{i1,}$ $x_{i2,}$ -------x_{id}). Each particle is treated asa point in a D-dimensional space. The best previous position (the best fitness value is called pBest) of any particle is recorded and represented as P_i= (p_{i1}, p_{i2}------p_{id}).Anther "best"value (called gBest)is recorded by all the particles in the population. This location is represented as P_g= ($p_{g1,}$ p_{g2}------p_{gd}). A t each time step, the rate of theposition changing velocity (accelerating) for particle iisrepresented as V_i= ($v_{i1,}$ v_{i2}-------v_{id}). Each particle movestoward its pBestand gBestlocations. The performance ofeach particle is measured according to a fitness function,which is related to the problem to be solved [3].

4. Simulation Results

This section represents the simulation frame work for the design of SAW filter using Particle Swarm Optimization. Simulation is carried out for certain specification such as T1 = 5 dB, T2 = 7 dB, central frequency = 1000 Hz.

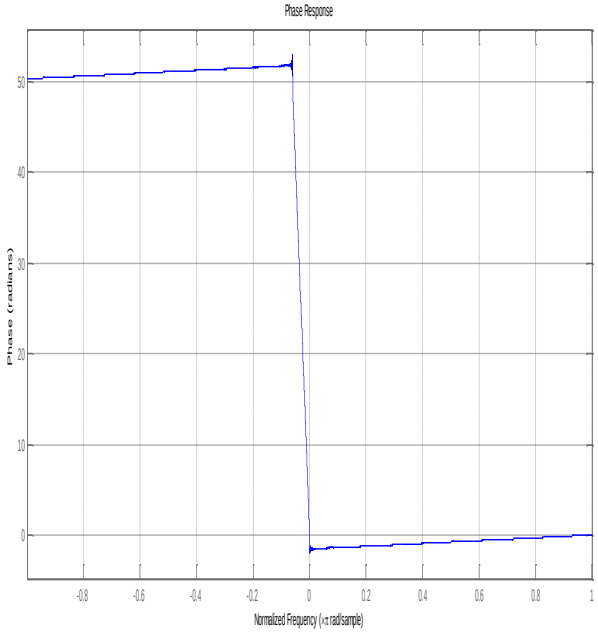

Fig1.normalized frequency and phase

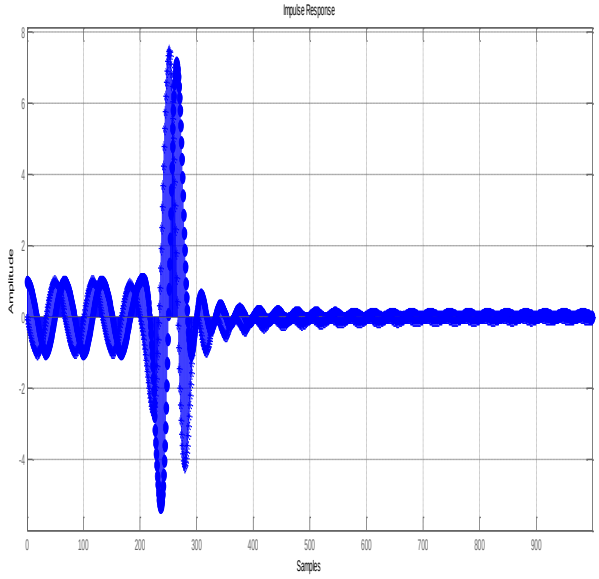

Fig2 .sample and amplitude

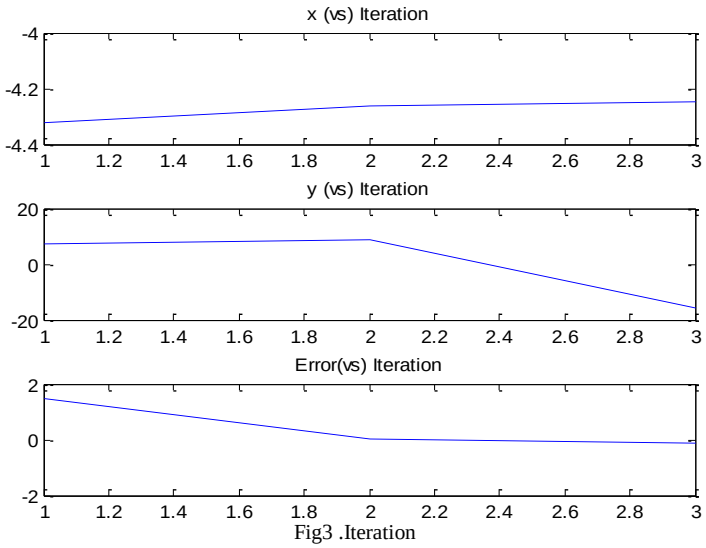

Fig3 .Iteration

T1 = -4.2486, T2 = -15.6277

5. Conclusion

This paper presents the optimization of SAW filter using Particle Swarm Optimization. We reach at the conclusion that frequency response of band pass SAW filter is improves as compared to the previous methods that are used for optimization of FR of SAW filter. Particle Swarm Optimization is a recently proposed random search algorithm and has been applied to many real-world problems, has a good global searching algorithm and gave good result.

References

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