Optimization the genetic and differential Evolution algorithms for digital SAW filter design

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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. 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. 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. 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, Heuristic method.**

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. Evolution Algorithms

It is difficult to imagine the variety of existing computational tasks and number of algorithms developed to solve them. Algorithms that either give nearly the right answer or provide a solution not for all instances of the problem are called heuristic algorithms. This group includes a plentiful spectrum of methods based on traditional techniques as well as specific ones. For the beginning we sum up the main principles of traditional search algorithms. The simplest of search algorithms is exhaustive search that tries all possible solutions from a predetermined set and subsequently picks the best one. Local search is a version of exhaustive search that only focuses on a limited area of the search space. Local search can be organized in different ways. Popular hill-climbing techniques belong to this class. Such algorithms consistently replace the current solution with the best of its neighbors if it is better than the current. For example, heuristics for the problem of intra group replication for multimedia distribution service based on Peer-to-Peer network is based on hill-climbing strategy .Divide and conquer algorithms try to split a problem into smaller problems that are easier to solve. Solutions of the small

problems must be combinable to a solution for the original one. This technique is effective but its use is limited because there is no a great number of problems that can be easily partitioned and combined in such way. Branch-and-bound technique is a critical enumeration of the search space. It enumerates, but constantly tries to rule out parts of the search space that cannot contain the best solution. Dynamic programming is an exhaustive search that avoids re-computation by storing the solutions of sub problems. The key point for using this technique is formulating the solution process as a recursion. The term heuristic used for algorithms which find solutions among all possible ones, but they do not guarantee that the best will be found, therefore they may be considered as approximately and not accurate algorithms.

3. 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 acoustic wave for an electronic application, 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.Fig.2.1 shows a SAW travelling along the plane surface of a solid material. 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 sagittal plane, i.e. the plane which includes the surface normal and the propagation direction.

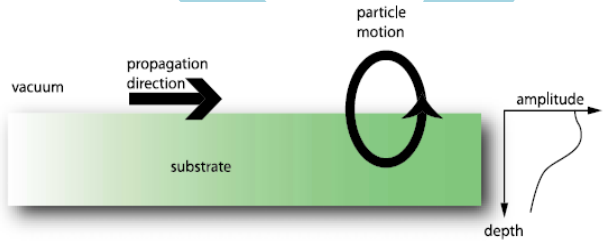

Fig 1. Basic Surface Acoustic Wave

4. Problem Identification

As a digital filter design method, the frequency sampling technique has attracted a great deal of attention The FS technique bas the advantages that more effective narrow band filters can be found easily, and those filters can be designed with an arbitrary response. However, how to find the values of the transition band frequency sample values that produce a filter with the maximum stop band attenuation is the key task in the FS. Using Tables method to design filter will result in a suboptimal solution. Recently, many evolutionary computation techniques, such as genetic algorithm and immune algorithm, were introduced to solve this problem. In this case, a new method is appeal to find the transition band frequency sample, which to make the filter optimal. Swarm intelligence is an evolutionary computation technique. Heuristic Algorithm is attractive because there are very few parameters to adjust, and it has been used for a wide range of applications. The search process take place only in the specified neighborhood and the final solution for optimization is only from that neighborhood. In the local search method, we start from any simple solution of the problem and then search for better solution in the neighborhood. When we got the better solution in the neighborhood, we switch to that solution and the process going on until we get the best solution in the specified neighborhood.

5. Simulation Results

This section represents the simulation frame work for the optimization of saw filter using genetic algorithm. Simulation is carried out for certain specification such as Number of generation=10: When number of generation is 10, the BW of the passband lie between 5-6 MHz and ripples amplitude lie between -10 to -30 dB and number of ripples are less as compared to previous results obtained from previous methods.

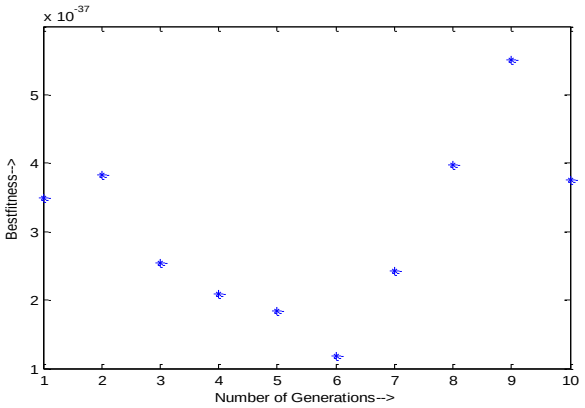

Fig 2. Bestfitness Vs Number of generation (=10)

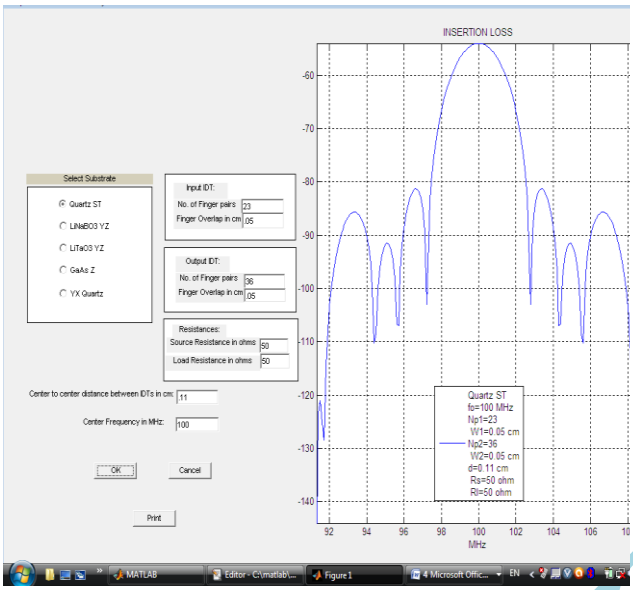

Fig 3. Insertion Loss (dB) Vs Frequency (MHz)

6. Conclusion

In this the improvement version were explored for the ordering of SAW filter coefficients. Their efficiency in reducing the switching activity could be proved, since after logically synthesized, the power results of filters data path were reduced. The best reduction, as expected, occurred in switching power, since it is more susceptible to the reordering. As the reduction in the internal cell power was not too large, the total power did not get a large reduction, but these results can be interesting in critical applications. Usually heuristic algorithms are developed to have low time complexity and applied to the complex problems. We briefly defined basic traditional and modern heuristic strategies. Due to their eminent characteristics they gained a great popularity. Recently appeared research results confirm the fact that their applications can be significantly enlarged in the future. It is possible to design digital filters with non-standard amplitude characteristics using the differential evolution algorithm.

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