DESIGN OF OPTIMIZED SAW FILTER USING HEURISTIC METHOD

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Abstract- Surface Acoustic Wave filter, a semiconductor device that is used to filter out desired frequencies.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.

Keywords: SAWFilter, Heuristicmethod, Optimization, GeneticAlgorithm, Inter-digital Transducer

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I. *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.

II. *Heuristic Algorithms*

The term heuristic is 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. These algorithms, usually find a solution close to the best one and they find it fast and easily. Sometimes these algorithms can be accurate, that is they actually find the best solution, but the algorithm is still called heuristic until this best solution is proven to be the best. The method used from a heuristic algorithm is one of the known methods, such as greediness, but in order to be easy and fast the algorithm ignores or even suppresses some of the problem's demands.

III. *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.

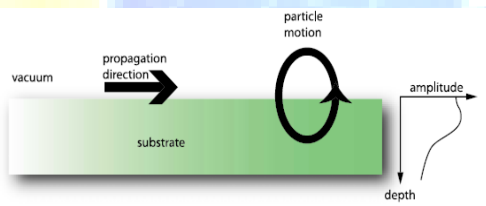

Fig 1. Basic Surface Acoustic Wave

IV. *SIMULATION RESULTS*

(i) No. of generation = 10, CF = 100MHz

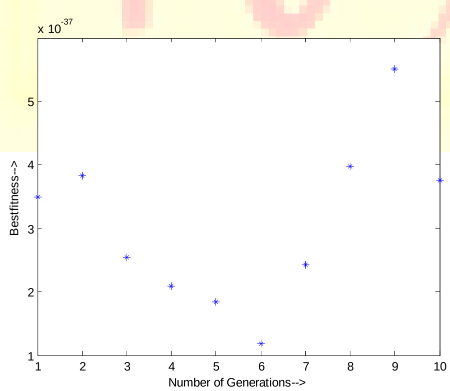

Fig. 2 Bestfitness Vs Number of generation (=10)

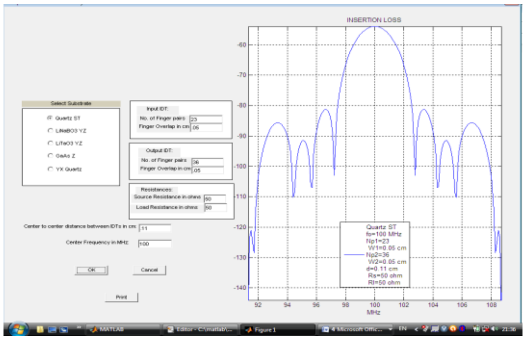

Fig 3 Insertion Loss (dB) Vs Frequency (MHz)

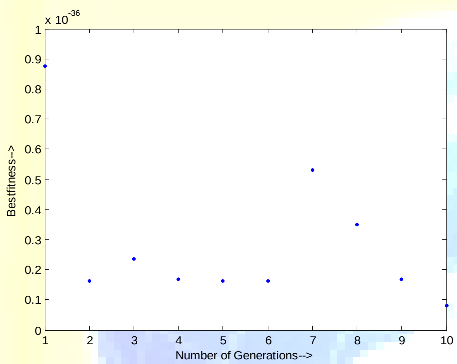

Fig. 4 Bestfitness Vs Number of generation (=10)

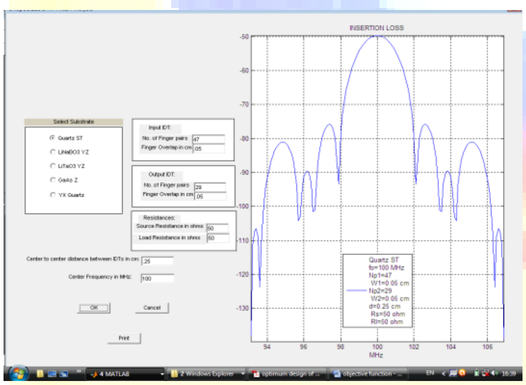

Fig 5 Insertion Loss (dB) Vs Frequency (MHz)

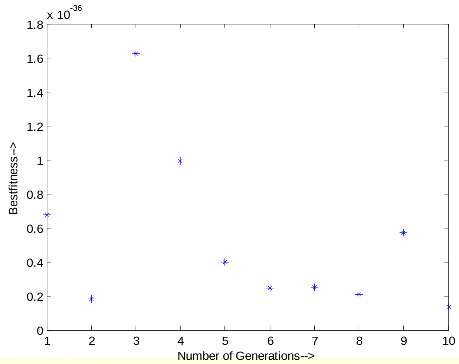

Fig. 6 Bestfitness Vs Number of generation (=10)

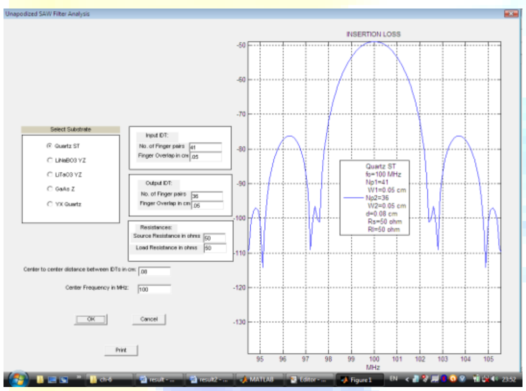

Fig 7 Insertion Loss (dB) Vs Frequency (MHz)

(ii) Number of generation = 20, CF = 100 MHz

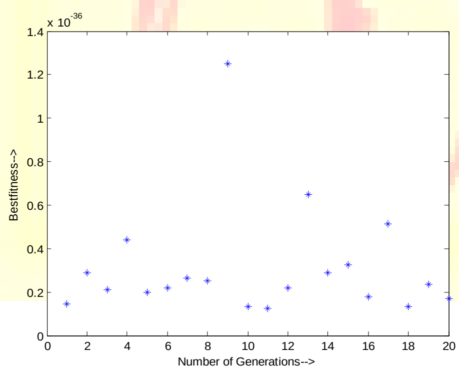

Fig. 8 Bestfitness Vs Number of generation (=20)

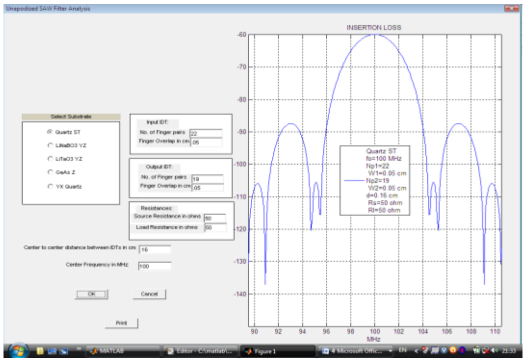

Fig 9 Insertion Loss (dB) Vs Frequency (MHz)

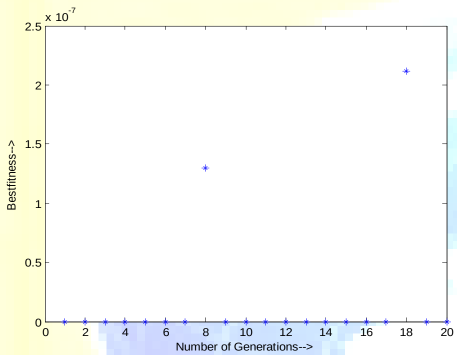

Fig. 10 Bestfitness Vs Number of generation (=20)

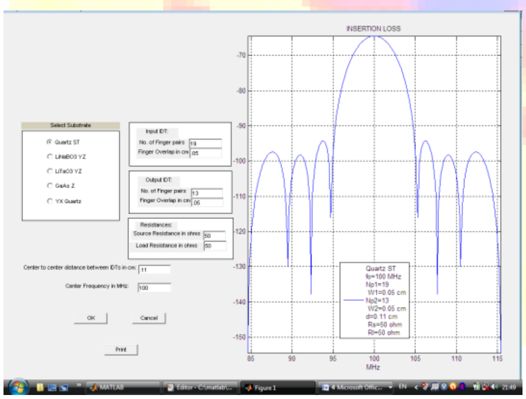

Fig 11 Insertion Loss (dB) Vs Frequency (MHz)

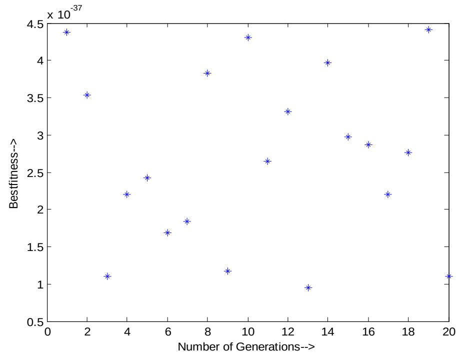

Fig. 12 Bestfitness Vs Number of generation (=20)

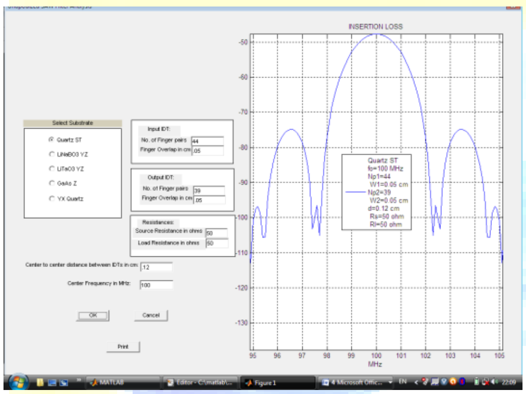

Fig 13 Insertion Loss (dB) Vs Frequency (MHz)

(iii) Number of generation = 50, CF = 100 MHz

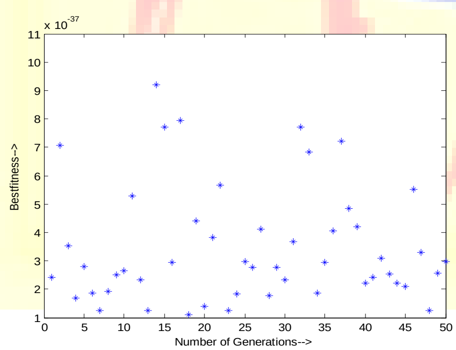

Fig. 14 Bestfitness Vs Number of generation (=50)

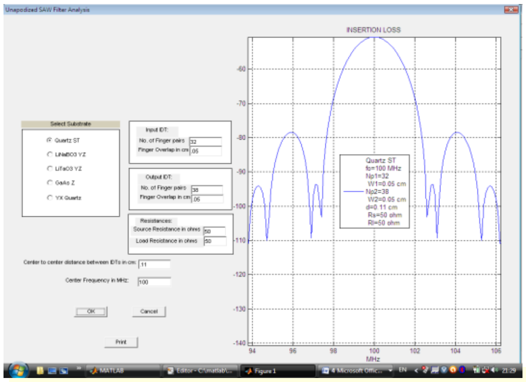

Fig 15 Insertion Loss (dB) Vs Frequency (MHz)

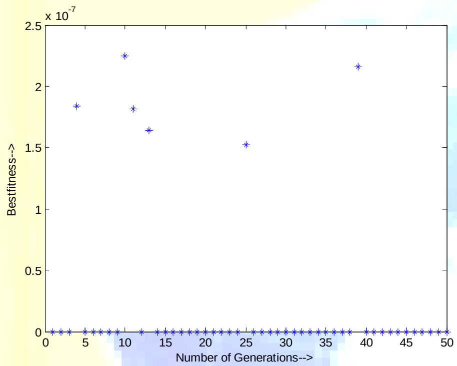

Fig. 16 Bestfitness Vs Number of generation (=50)

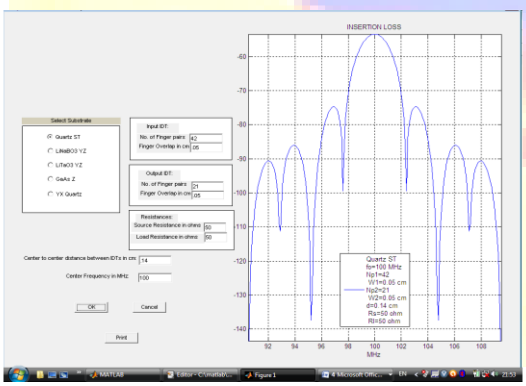

Fig 17 Insertion Loss (dB) Vs Frequency (MHz)

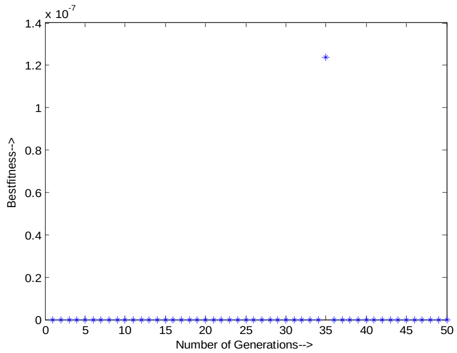

Fig. 18 Bestfitness Vs Number of generation (=50)

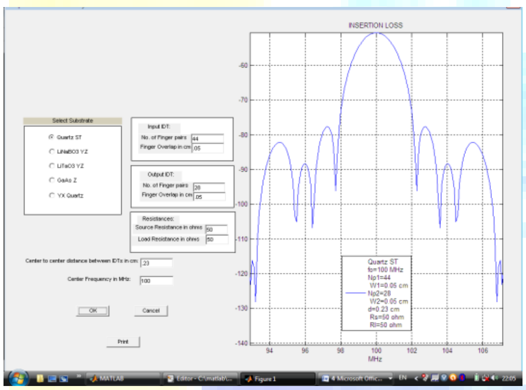

Fig 19 Insertion Loss (dB) Vs Frequency (MHz)

(iv) Number of generation = 100, CF = 100 MHz

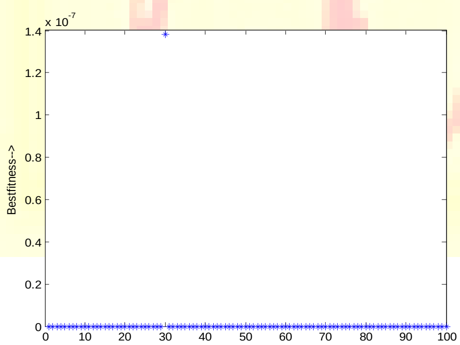

Fig.20 Bestfitness Vs Number of generation(=100)

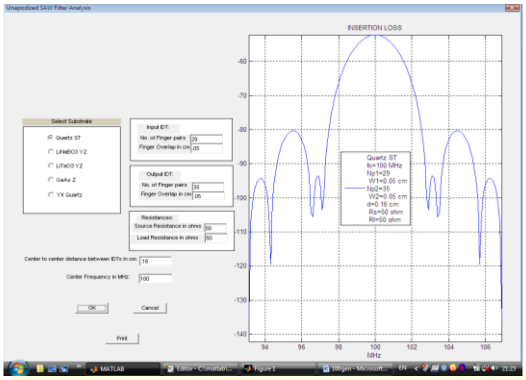

Fig 21 Insertion Loss (dB) Vs Frequency (MHz)

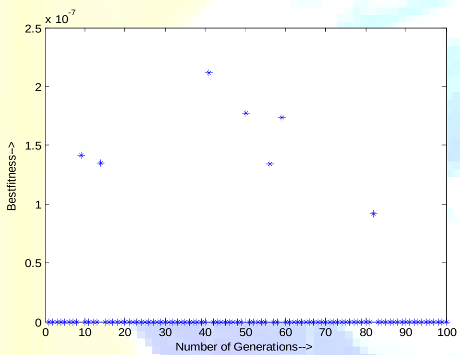

Fig.22 Bestfitness Vs Number of generation(=100)

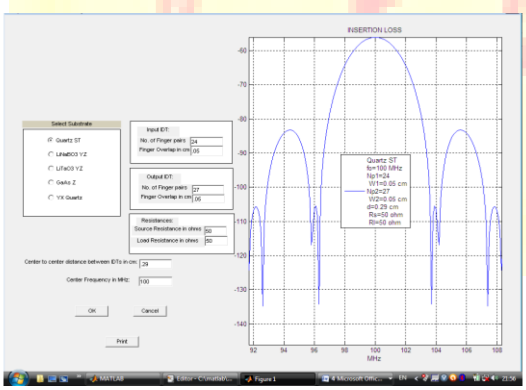

Fig 23 Insertion Loss (dB) Vs Frequency (MHz)

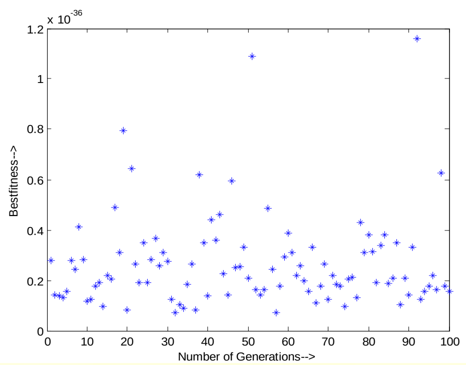

Fig.24 Bestfitness Vs Number of generation(=100)

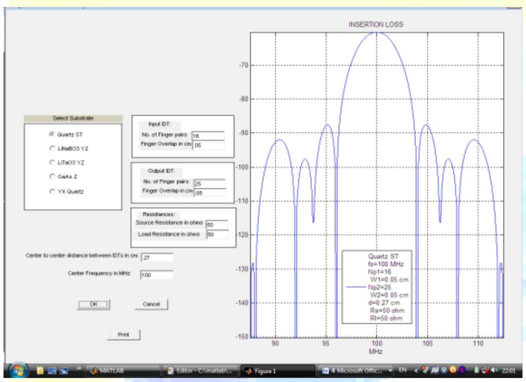

Fig 25 Insertion Loss (dB) Vs Frequency (MHz)

A.*Comparison:*

We had shown the four cases regarding FR of bandpass SAW filter in section 6.2:

(i) 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.

(ii) Number of generation=20: When number of generation is 20, the BW of the passband lie between 5-10 MHz and ripples amplitude lie between -10 to -32 dB and number of ripples are less as compared to previous results obtained from previous methods. As compared to case (i), the BW improved almost in double multiplication with ripples amplitude increase slightly.

(iii) Number of generation=50: When number of generation is 50, the BW of the passband is approximately 5 MHz and ripples amplitude lie between -15 to -32 dB and number of ripples are less as compared to previous results obtained from previous methods. As compared to previous case (i) and case (ii) the BW is reduce in this case while the lower range of ripples amplitude increase from -10 dB to -15dB

(iv) Number of generation=100: When number of generation is 100, the BW of the passband lie between 6-8 MHz and ripples amplitude lie between -10 to -55 dB and number of ripples are less as compared to previous results obtained from previous methods. As compared to previous case (i) and case (iii) the BW is increase in this case while the ripples amplitude range is highest in this case.

V. *CONCLUSION*

This paper presents the optimization of saw filter using Heuristic method. 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. The improvements in the FR of SAW filter are in terms of BW and ripples amplitude take place with HA technique.

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