A REVIEW STUDY ON COMPARISON OF GENETIC ALGORITHM AND BRAIN STORM ALGORITHM

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Abstract- optimization is a process in which a number of variables should be achieved to find the best result from all data set.
There are many type of optimization algorithm is introduced in electromagnetic. Basically there are two types of algorithms local algorithms and global algorithms. The requirement of global algorithm is more because they can give the better result as comparison to local algorithm. In this paper two types of global optimization algorithms are reviewed and compared there results with each other.
Genetic algorithm and brain storm algorithm both are applied to microstrip patch antenna and their behavior and result are compared for patch antenna.

***Index terms*- Microstrip patch antenna, Optimization, Genetic algorithm, Brain storm algorithm**

I INTRODUCTION

Technology is the trend for modern age, in present environment the new technology is introduced to make a new invention day by day [1-2]. For this the challenged for an engineer is increase to push technology to a broad path by making new designs and recreating the previous one [3]. For a new creation the hit and run methods is very long process and particularly when it applies for a large number of data set. The best solution for this is the software tool that makes possible the simulation of very complex designs and optimizes them to reach the best solution. International optimization tools give a new organized method for finding the optimum designs. The use of global optimization algorithms in antenna and microwave engineering is not new [4-5]. Genetic algorithms (GAs), evolutionary programming, particle swarm optimization (PSO), differential evolution, invasive weed optimization, covariance matrix adaptation evolution strategy, ant colony optimization, and fruit-fly optimization algorithm have been used to solve electromagnetic (EM) problems. However, a relatively new global optimization algorithm, brain storm optimization (BSO)—has not yet been applied in antenna and EM applications [6-7].
In this paper, the comparison between these two algorithm is given the genetic algorithm (GA) is base on natured inspired process for everyone in this data is picked randomly and then worked on them with all process. In brain storm algorithm (BSO) process is worked on the base of human's brain storming. This paper include the description of GA in section II, and then section III covers the brief theory of BSO, in section IV the design of patch antenna with both algorithm is discussed and section V conclude this thesis.

II GENETIC ALGORITHM OPTIMIZATION

A functional block diagram of simple genetic algorithm is shown in figure 1. Genetic algorithms are robust, stochastic-based search methods, which can handle the common characteristics of electromagnetic optimization problems that are not readily handled by other traditional optimization methods. The working of this algorithm is dived in three parts: (i) initiation, (ii) reproduction, (iii) generation replacement. In this algorithm the initial population is randomly created generally it is a parameter string or a set of chromosome. This parameter set is called individual and the set of individual is called current generation. For each individual the fitness function is applied. After the initialization the reproduction process is done. In reproduction a pair of individuals are selected which is called parents and a pair of parents go for the process of crossover and mutation. With this crossover process pair of children is generated and these children are called new generation. These process of selection, crossover and mutation are repeated until the requirement criteria is met. After this when a complete new generation is produced it replace the old generation and then fitness value are evaluated with the each individual of new generation. In genetic algorithm the old generation is overlapped by new one that's why this algorithm is called steady state algorithm. When the overlapping is completely done the termination criteria is met and the process is complete.

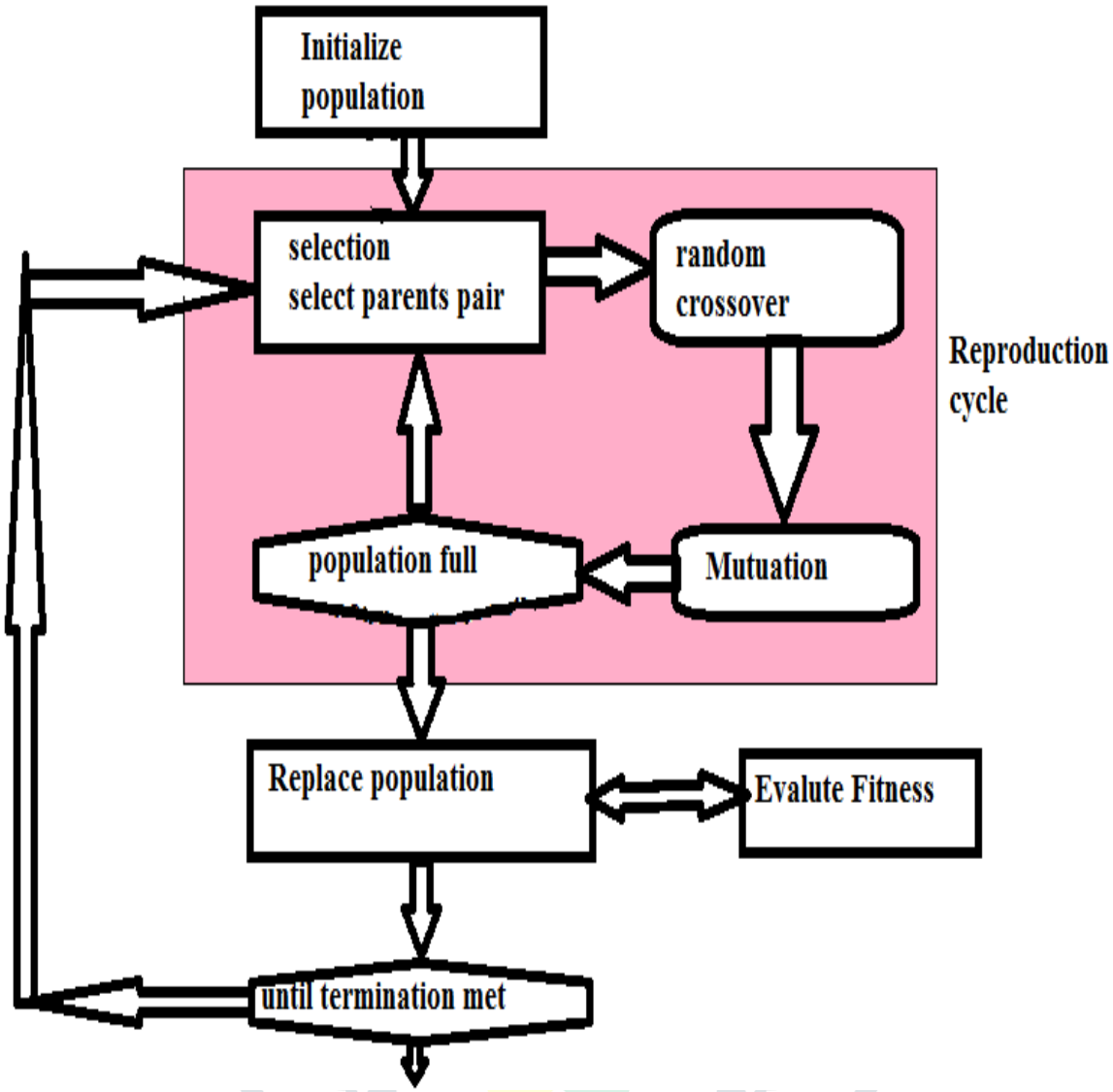

FIGURE:1 Working methodology of genetic algorithm

III BRAIN STORM OPTIMIZATION ALGORITHM

Brain-stroming is a technique which is widely used in a group of people for creative thinking. With each individual contributing to the generation of ideas using different approach from a different background, the brainstorming process improves the probability of finding a solution because it organizes ideas that are generated from a diverse group of individuals. Idea of BSO is start with N individuals which are generated N ideas. These ideas are then divided into M group of similar categories. From these M groups the best idea is selected. These ideas are generated based on Osborn's rule.

(1) NOT suspend to anyone: According to this rule all ideas are good.
(2) Sharing : This rule says every idea should be shared.
(3) Mixing : This rule says new idea should be generated by combining the bunch of previous idea.
(4) Qunatity : According to this rule for achieving a good quality answer the numbers of idea should be more.

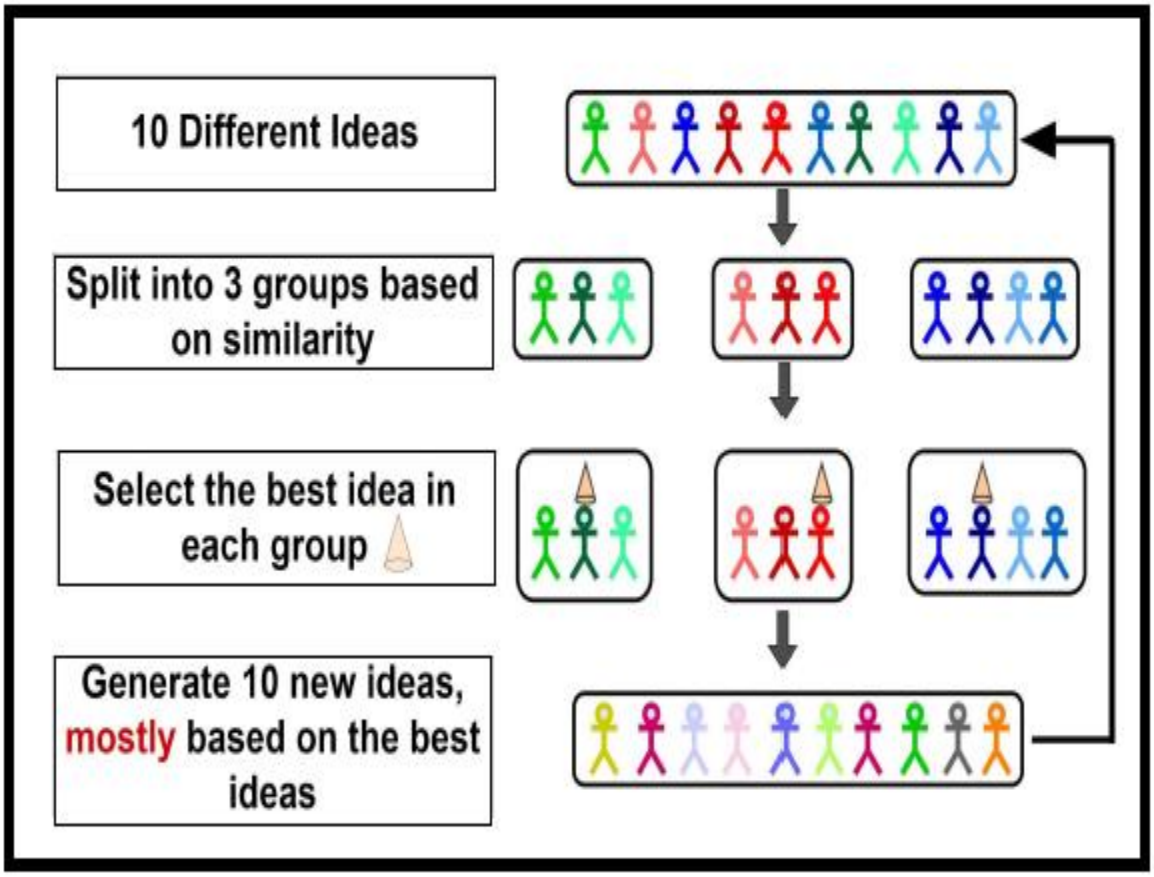

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FIGURE:2 Basic Concept of BSO

3.1 BSO Algorithm

The terms used in BSO is given by figure-2. It is defined by the following steps

(1)Initialize the process: In this step two main work is done (i) random ideas are selected from 100 individuals (ii) applying clustering technique.

$$X = \chi_i = [\chi_i^1, \chi_i^2, \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots, \chi_i^D] \qquad 1 \le i \le N \qquad (1)$$

Here i th variable represent the no. of individuals and D represent the dimensional search space.

$$\chi_i^d = \chi_{min}^d + rand() * (\chi_{max}^d - \chi_{min}^d), \qquad 1 \le d \le D \qquad (2)$$

Here $(\chi_{min}^d, \chi_{max}^d)$ are smallest and highest values of d^{th} dimension in a D-dimensional optimization. In equation rand() represent the random number of variable.

(2) Clustering Ideas: Based on the location in the search space, the N idea divided into M groups so that ideas closer to each other belong to the same cluster as shown in figure-2. Clustering strategy is a major STEP in BSO.

(3) Rank Ideas: By pre defined values as the fitness function is applied to the ideas a best idea is selected from each cluster.

(4) Disrupting Cluster Center: In this the random idea is generated and it is replaced by the population of ideas and it is controlled by $P_{replace}$.

(5) *Updating Ideas*: Now the new idea is generated by generating the new solution and it is divided into two parts. One is the generated by one cluster and other one is generated by two cluster and this operation is controlled by $P_{generation}$. The idea is generated on the base of two cluster is-

$$\begin{cases} one - cluster\ path & rand\ (\ ) < p_{generation} \\ two - cluster\ path & otherwise. \end{cases} \qquad (3)$$

$P_{generation}$ is selected here as 0.8.

(a)Idea generation from one cluster: In this the idea is selected on random basis or a center idea is selected and this is controlled by *PoneCluster.* The random number is selected between 0,1 and if it is less than by predetermined value center value is selected. Here it is chosen as 0.4and it is generated as-

$$\mathcal{X}_{new}^{d} = \mathcal{X}_{selected}^{d} + \xi * \mathcal{N}\ (0,1) \quad (4)$$

Here *d* represent the dimension index, and $\mathcal{N}\ (0,1)$ is the representing the Gaussian random value mean 0 and variance 1, and ξ is a coefficient to manage the involvement of the Gaussian random value and calculated as follows:

$$\xi(t) = \alpha * rand(\,) * \exp\left(1 - \frac{1}{T - t + 1}\right) \quad (5)$$

Here *T* represents the maximum number of generations, *t* is the number of current generation, and α is a dependent parameter that is effected by search space size

$$\alpha = 0.25 * (\mathcal{X}_{max} - \mathcal{X}_{min}) \quad (6)$$

Here α is the value of initial generation for encouraged the exploration. ξ is the weighting coefficient which represent the larger value of initial iteration and smaller value of final iteration. This will give the strength to generate more ideas.

(b) Two-Cluster Idea Generation: This process is similar to the one cluster idea but the difference is it chooses randomly two clusters and it is controlled by $P_{TwoCluster}$. This value is chosen as 0.5and the two selecting ideas are combining by this formula given in equation (7).

$$\mathcal{X}_{selected}^{d} = R * \mathcal{X}_{selected1}^{d} + [1 - R] * \mathcal{X}_{selected2}^{d} \quad (7)$$

Here R ia the random number generated between 0 and 1. The flowchart is shown in figure 3.

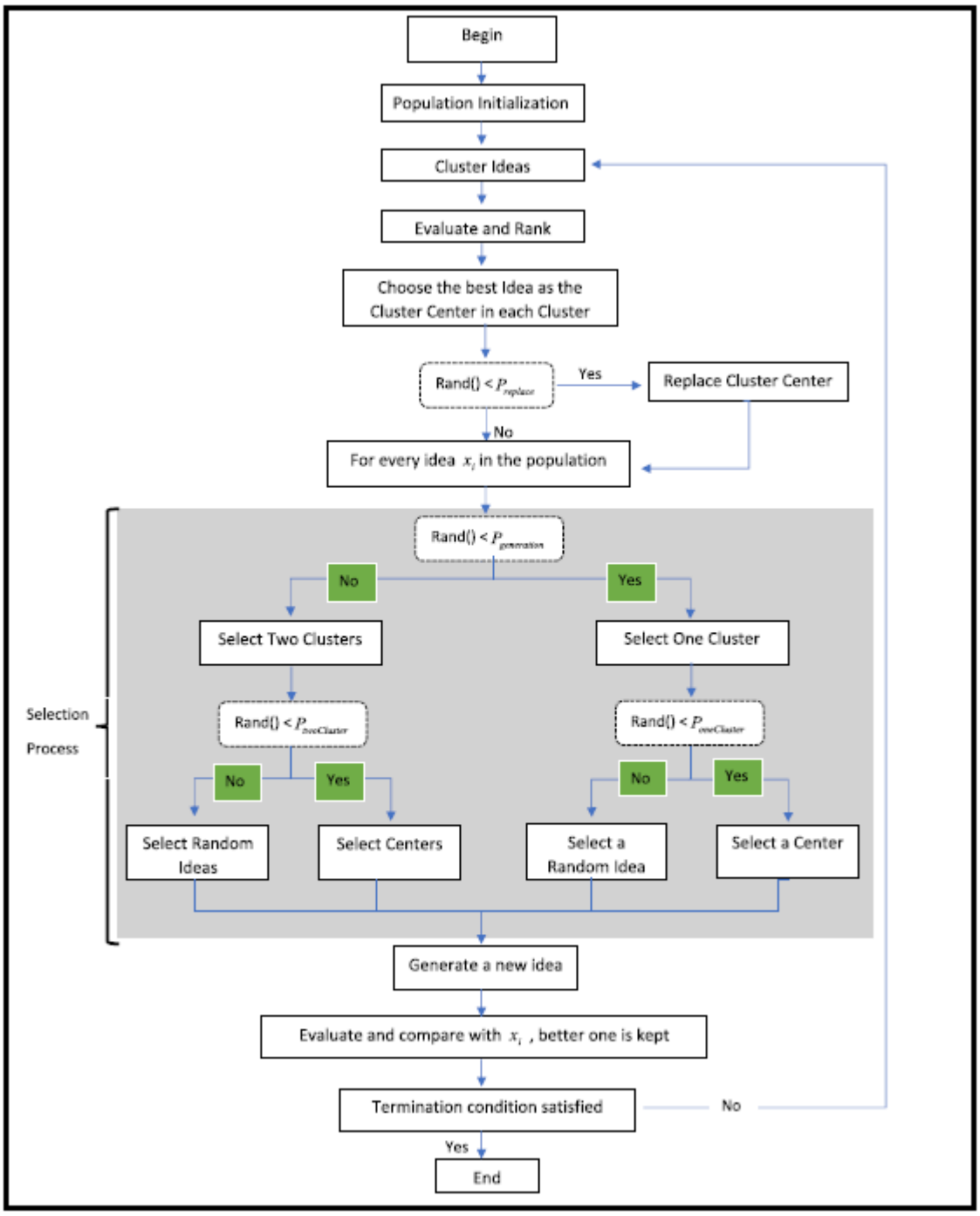

FIGURE: 3 BSO algorithm

IV MICROSTRIP PATCH ANTENNA DESIGN

4.1 MPA design by GA

In this design the material is used with dielectric constant of2.20 and the loss tangent is 0.0007, the thickness of this material is 62mils. The patch antenna works on the resonance frequency of 3GHz and its dimension is given in mm. the optimization is done for lower resonance frequency and the parameter for optimization is applied with crossover probability is 0.1 and mutation rate is 0.6 and the reference frequency is chosen as 4 GHz. The diagram of patch antenna is shown in figure-4. By this optimized design 1.738 GHz frequency is obtained and the size is reduced 42%.but the time of computation is very high which is 20h. Two tools are used to see the variation of resonance frequency. ENSEMBLE and IE3D shows the value of resonance frequency is 1.795 GHz and 1.847 GHz..

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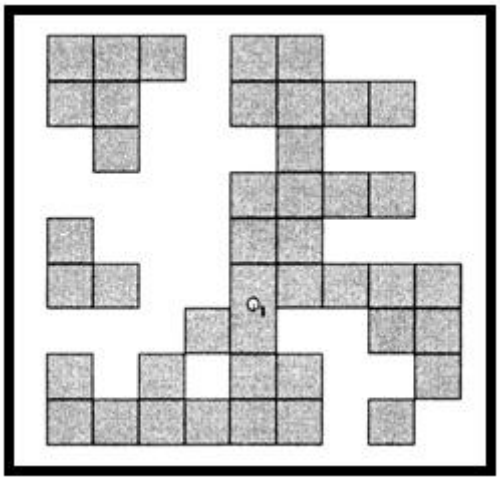

Figure-4 optimized patch using GA

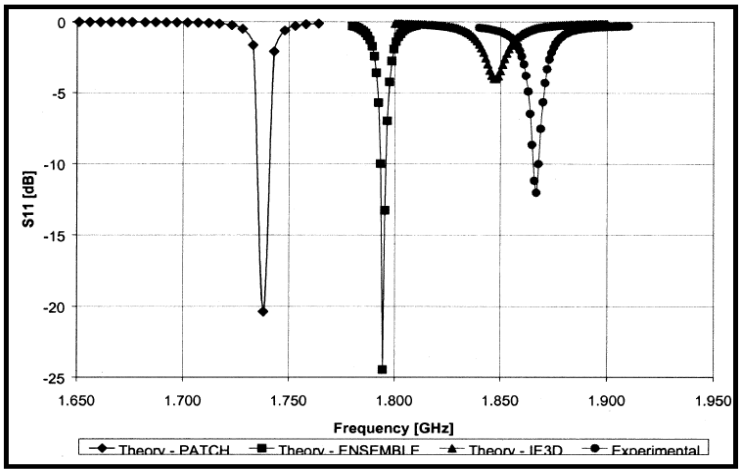

Figure-5 Result of optimized MPA

From the result of these two software simulations the variation of resonance frequency is 6.9% and 3.9%, respectively. The maximum gain obtained from this is 1dB.

4.2 MPA design by BSO

For optimizing by BSO the number of ideas are used 25 and 4 clusters are used with scaling factor $\gamma = 0.25$. For minimize the computation time in HFSS the number of generation is used 100 which gives the result of 2500 evaluation and 5% number are used from it. The fitness function ($S_{11} \leq -10dB$) is used in BSO for two resonance frequency (1.9 and 2.4 GHz) and the result is obtained as 1.96 and 2.28 GHz which gives the wide bandwidth. Figure 6 and 7 shows the antenna design and its return loss graph. Here yellow block shows the ON state.

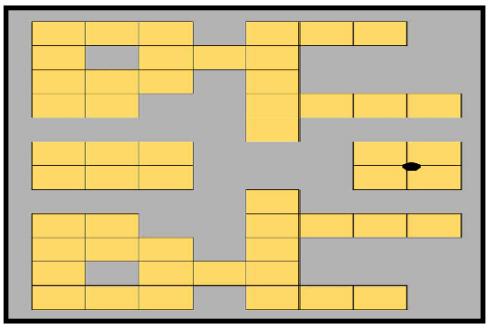

Figure-6 dimension of patch antenna

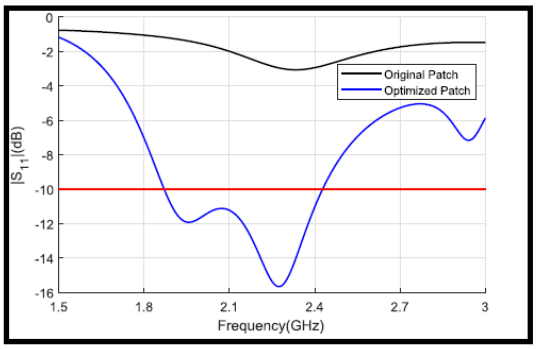

Figure-7 result of optimized and un-optimized antenna

IV CONCLUSION

This paper presents the review comparison between genetic algorithm and brain storm algorithm. In both algorithms pixilated antenna is used for dual-band behavior. Both algorithms are best in their work even BSO is more sharp in comparison of GA but more research is required now on BSO. Till the date whatever work is done on BSO it shows its complexity more than the GA and it takes more time as comparison of GA. For future work, BSO is simplified to become more user friendly and testing with different antennas and combined with other optimization algorithms.

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