CAIWO based DRR usage in Antenna Array Synthesis

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Abstract— For the requirement of highly directed patterns in case of mobile communication and spatial detection planar as well as circular antenna arrays require pattern synthesis. IWO and the improved version of CAIWO with dynamic range ratio trade of enhance results in SLL while neglecting mutual coupling by proper selection of dynamic factor in 20-30db range. Remarkable improvement in results has been achieved by CAIWO based DRR with change in chaotic factor.

Keywords — IWO, CAIWO, Dynamic Range Ratio, SLL

I. Introduction

For optimal enhancement of characteristics of antenna arrays the focus has been on side lobe suppression. Production of nulls in the line of interference or shape of power pattern [1], it is worth noting that modification of inter element spacing and complex excitation like amplitude and phases are amenable to change. Synthesis problems have constraints in minimization of null, first null beam width as well as Dynamic range ratio (DRR) to be within a limit for current distribution [2]. As analytical synthesis methods face many problems like being stuck in local minima, methods inspired by natural phenomena have been giving popularity.

In [3], the algorithm based on stochastic method following the behavior of colonizing the weed in nature IWO (invasive weed optimization) has been proposed. For faster convergence and greater accuracy chaotic method [CAIWO] has been utilized [4].

In this paper, the dynamic IWO suggested by [9] has been further improved by application of CAIWO based on DRR.

II. Related Work

A modified IWO has been proposed [5] synthesis of large planar thinned array using iterative Fourier technique. A modified IWO was used for compact coplanar waveguide printed ultra wideband antenna [6]. For reading the standard deviation of a weed according to its cost function was done by [7]. Further, multiobjective IWO has used for non dominating sorting of solutions for conformal phased antenna array [8].

Kenare[9] suggested dynamic IWO to find out optimal amplitude weights which permit broad null and suppression of SLL by keeping the main beam width of reference pattern.

III. Methodology

It is pertinent to note that success of CAIWO is impacted by variance of the chaotic factor. Prior to usage of the chaotic map, the variables are normalized in the range (0, 1). A new value is determined by sinusoidal sequence

$$\breve{X}^{|} = X_{min} + \breve{X}\,(X_{max} - X_{min}) \quad (1)$$

Using a sinusoidal map, chaotic distribution is performed. In the second phase, classification and reusing of each weed is done according to its appropriateness. In the final phase, SD of current generation is added as per the position in the colony.

$$\sigma_j = \sigma_{current} * \frac{j}{p_{sum}} \quad (2)$$

j = list of weeds

P_{sum} = Total no. of weeds in the current generation

σ_j = SD of j^{th} weed produce seeds.

Later, adaptive SD is utilized for dispersal of new seeds at random.

$$\sigma_{current} = \frac{(iter_{max} - iter)^n}{iter_{max}^n}(\sigma_{initial} - \sigma_{final}) + \sigma_{final} \quad (3)$$

Afterwards, the new seeds are flocked to the vicinity of new parent weed using a sinusoidal map.

$$X_{k+1} = AX_{k^2}\sin(\Pi X_k) \quad (4)$$

In case the seed is distributed randomly having higher fitness, the survival of the seed is better. Else, the search continues.

IV. Flowchart of CAIWO

In case of IWO, standard deviation affects the performance, logistic chaotic mapping can be used for standard devition. The improved chaotic weed algorithm has the advantage of convergence rate and high accuracy. It is imperitive to noted that IWO is efficient interms of global search; however, its exploration ability is not adaquate. Further, random parameters of the weed algorithm lower its performance and hence allocation of the appropriate global coverage to the entire search space is not possible. The implementation of the algoritm does not vary much until the termination condition is met. The balance between exploration and exploitation does not get the right importance affecting the accuracy and speed adversely. Other shortcomings include early interpretation and productivity of being trapped in local minima and low population diversity.

Rather than starting with a basic population of weed a randomly generated initial chaotic population is used to produce more diverse seed population.

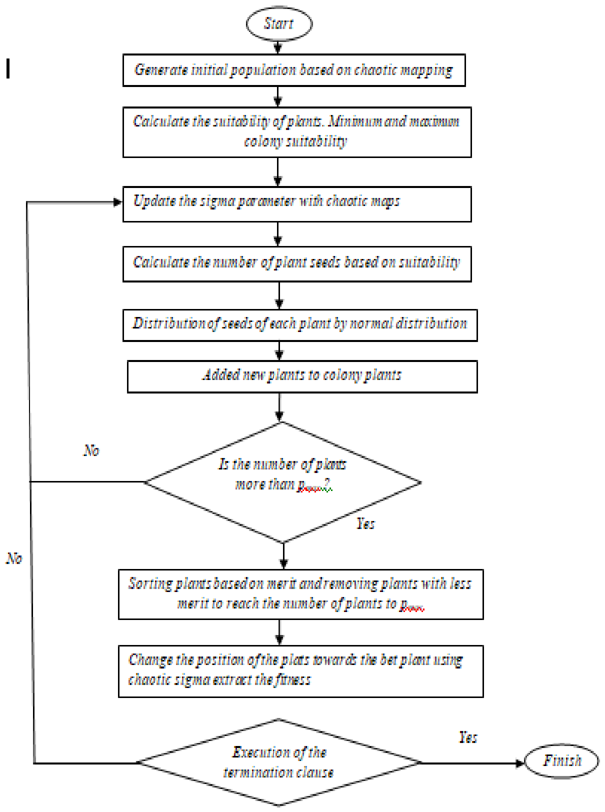

Figure 1: Flowchart of CAIWO

IV. RESULTS

a) Chaos Factor

i) From the figure 2, it is observed that value C:1.99e8 and N=9 the SLL has achieved a 10 db in CAIWO and 15 db in IWO.

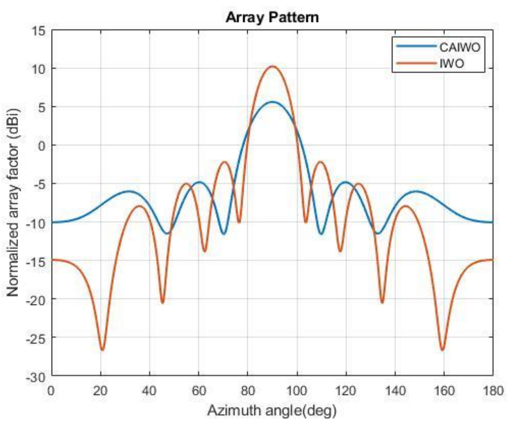

Figure 2: C=1.99e8, N=9

ii) From the figure 3, it is observed that value C: 2.2111e8 and N=9 the SLL has achieved a 09 db in CAIWO and 14 db in IWO.

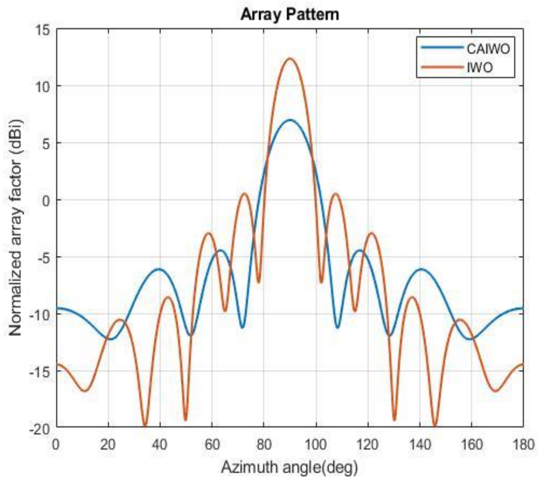

Figure 3: C=2.2111, N=9

iii) From the figure 4, it is observed that value C:2.311e8 and N=9 the SLL has achieved a 08 db in CAIWO and 10 db in IWO.

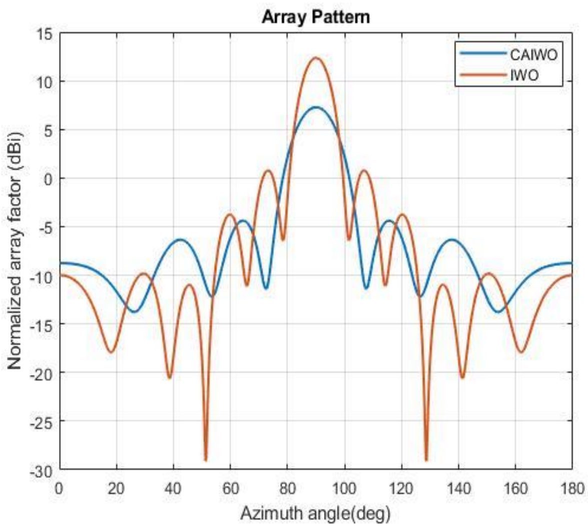

Figure 4: C=2.311e8, N=9

iv) From the figure 5, it is observed that value C: 2.45e8 and N=9 the SLL has achieved a 11 db in CAIWO and 09 db in IWO.

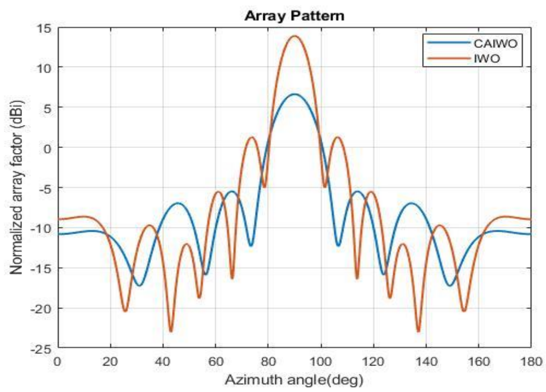

Figure 5: C=2.45e8, N=9

v) From the figure 6, it is observed that value C: 2.511e8 and N=9 the SLL has achieved a 11 db in CAIWO and 9.4 db in IWO.

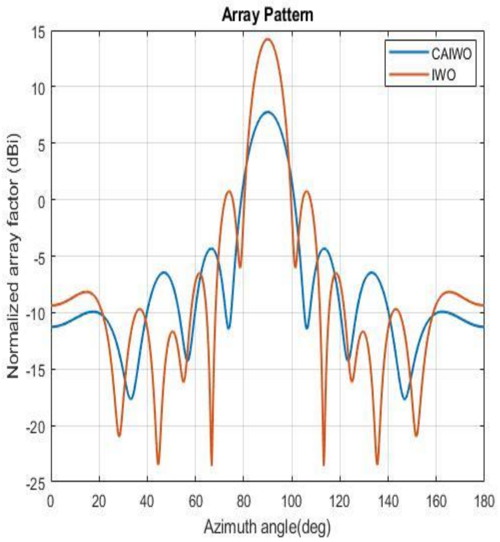

Figure 6: C=2.45e8, N=9

b) DRR Comparison

Pattern	Normalized Current	DRR
IWO	0.9693 0.9610 0.9257 0.8528 0.7427 0.6093 0.4534 0.3312 0.2335 0.2752	4.20
CAIWO	**0.9681 0.9592 0.9102 0.8421 0.6954 0.6012 0.4502 0.3291 0.2221 0.2621**	**4.31**

Table 1: DRR Comparison

Kenane suggested DRR method. Our paper has combined both DRR and CAIWO and the results have been tabulated in Table 1 for comparison. The values DIWO (kenane) and CAIWO have been presented. The best value is that of CAIWO at DRR of 4.31

VI. CONCLUSION

To design antenna array radiation patterns, IWO is substituted by CAIWO by variation of chaotic factor. Many circumstantial parameters such as convergence, periodicity and chaos are considered by varying factor from 1 to 3. The sinusoidal map is optimized for the critical value of 2.3 for effectively balancing exploitation and exploration. Due to number of drawbacks of analytical methods, such evolutionary techniques using optimized DRR of excitation amplitudes help in accomplishing proper array feeding.

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