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Effect of chaos factor in radiation pattern in planner antenna arrays with chaos adaptive invasive weed optimization

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ABSTRACT

For mobile communication and spatial detection of antennas should have high directive radiation pattern, in this context pattern synthesis of planar circular antenna arrays is highly significant such design has been done inverse weed optimization. The basic objective e is to study invasive weed optimization in compression with modified chaotic adaptive invasive weed optimization. The focus of the study is the effect of chaotic factors suitable for sinusoidal mapping for chaos as applicable to the context of the design of antennas. Taking various numbers of elements of the antenna and the distance between the antenna's radiation patterns are studied by varying chaos factors through MATLAB programming. It is found that the critical point of 2.3 for chaos factor makes the map enter into phase of chaos prior to the critical point is a phase of periodicity starting with chaos factor of 2. Below this value there is no chaos but a phase of convergence. These phases are useful having a trade of convergence and chaos. By varying the factor of chaos the impact on the radiation factor of non-uniform planar antennas has been found to give phases of convergence of chaos which are essential for making trade of between exploitation and exploration required in optimization.

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1. INTRODUCTION

For Invasive weed optimization (IWO), standard deviation affects the performance logistic chaotic mapping can be used for standard deviation. The improved chaotic weed algorithm has the advantages of convergence rate and higher accuracy [1]. IWO is quite efficient in terms of global search. Its exploration ability is not adequate. Furthermore, the finest person in the room isn't being used [2]. In addition, the rand parameter of the weed algorithm reduces its efficiency, therefore the allocation of adequate global coverage to the additional search field is incorrect [3]. Improving the extraction process cannot be done in any precise way [4]. Until the algorithm's termination condition is reached, nothing changes in its implementation. Finally, failure to strike the correct balance between exploration and exploitation has a negative impact on accuracy and speed. Additionally, there is a lack of early integration and a lack of variety in population [5]. The chaos theory is basically used to examine the behavior of certain aspects which are to the critical condition. For a given region, chaotic search has access to most. As a result, the population's geographic variety is enhanced. It is now possible to explore more of the search space. As a result, the solutions would be evenly distributed over the globe. This method is quite effective in locating the ideal answer [6]. Rather than starting with a seed population of weeds, the researchers want to employ a randomly generated initial chaotic population, which they hope would produce a more diverse seed population [7]. In addition, it is made certain that the members of the population cover the whole search area. As an alternative, the optimal location is determined using an equation [8]. It is because of these chaotic maps that the SD parameter [9] for which a big value is anticipated to begin the method has a tiny value at its conclusion. Exploration is aided by a large value at the outset. It is necessary to set a modest value for this parameter to proceed with extraction at this point since optimum global is nearing. According to chaos theory, both exploration and profit may be achieved [10].

The aim of thisresearch is to improve MATLAB based CAIWO algorithm for suitable for antenna analysis [11]. The following sections are: Related work, methods, design aspects followed by results and conclusion. The optimization of invasive weeds has been used to address issues in electromagnetic fields [12]. Being a stochastic searching process, it suffers from false on undesirable convergence in multimodal fitness landscapes [13]. To circumvent these problems, CAIWO has been adopted by based on chaos theory. It replicates the colonisation and dispersal of weeds [14] via IWO. Initialization, reproduction, geographical dispersion, and competitive exclusion are the primary phases. Seed production at IWO is based on a predetermined geographic distribution, and as a result, there is an imbalance between exploration and exploitation. Unknown whether chaotic search strategies have a better probability of escaping the local minima. As a result, the CAIWO algorithm is less likely than the basic IWO to reach convergence too soon. IWO's performance is improved by using a sinusoidal map instead of a logistic map or a tent map [15].

2. LITERATURE SURVEY

Li and Mao [16] with the use of three distinct forms of particle swarm optimization (PSO), the augmented SVM model's performance has been strengthened. PSO with time-varying acceleration coefficients, PSO with the constriction factor, and traditional PSO are examples of these (K-PSO). In addition, a reliable dataset for the SVM classifier may be constructed using pseudorandom binary sequence (PRBS) based temporal domain reflectometry (TDR). Using a two-branch distribution line, researchers were able to determine the best PSO variation for brief fault identification. Tripathi *et al.* [17] traction substation control concerns need improvements to the single-phase system's overall performance. It's possible that a voltage and current imbalance at the single-phase transformer will result if you connect a three-phase traction system to a single-phase grid. Additionally, the spread of harmonic distortion, negative sequence currents, and reactive power difficulties are all contributing to the current traction system's dissatisfaction.

Dhaliwal and Pattnaik [18] analyzing how well CAIWO performs requires minimizing numerous sample benchmark functions using a variety of optimization strategies. Algorithm convergence speed and exploration capability are both greatly improved by using the suggested technique, as shown by numerical results. To get a radiation pattern with the greatest possible decrease in side-lobe level (SLL) for varied numbers of antenna elements, the CAIWO method is also used to discover an ideal set of weights and spacing between antenna elements.

A statistically significant difference has been found between CAIWO's design outcomes and those of other current metaheuristics. Iyampalam and Ganesan [19] analyzing piezoelectric energy harvesting technology is the goal of this research different modelling methodologies are explored and compared and the best cantilever beam and piezoelectric patch form and material are selected after a literature review is completed. Experiment put up at Hokkaido University's Robotics and Dynamics Lab, however owing to time constraints and a lack of certain experimental equipment, the experiment was not finished Thakare [20]. An improved binary IWO (IBIWO) for thinned circular array pattern creation is proposed in this study by the authors.

At least a half-wavelength spacing, evenly stimulated, and half-thickness-thinned concentric circular array with the same no. of elements and rings has an half power beamwidth (HPBW) of 50% or less. DE, MPSO, and BBO simulation results are compared to the suggested models findings to prove its efficacy for concentric circular arrays [20]. Gupta and Mathur [21] as well as the no. of turns and the size of the coils in the system, this method took into account the total system output power and efficiency. Varamini *et al.* [22] support vector machine (SVM) techniques are used to identify these characteristics later in the classification process. These strategies improve performance in noisy environments while dealing with big volumes of data, according to the assessment results [22]. Jawad *et al.* [23] invasive weed optimization has been extensively used in the electromagnetic (EM) area as an effective optimization technique.

Based on simulations of suggested thinning arrays by IBIWO, the proposed approach is evaluated against published findings [23]. Sharmaand and Sharma [24] one way to keep an eye on machine health and alert users when anything goes wrong is to use this paper's node MCU-based intelligent monitoring system. The technology was able to cut the time it took for technicians to call and report on maintenance work by half [24]. Online and real-time maintenance history data will aid in the development of a new maintenance plan [25]. Saikumar *et al.* [26] large concentric circular antenna arrays (CCAA) with high sidelobe levels may be reduced using a new hybrid CNN technique. Weed-based Lévy flying with chaotic initialization from CSIWA may be used to tackle the problem of optimizing the continuous excitation current [26].

3. RESEARCH METHOD

As a phenomenon, weed searches of optimal condition and adapts itself to environmental conditions resisting radiation. Inspired by weeds, IWO uses population-level optimization to find the best solution for each given problem. Standard deviation (SD) affects the performance of algorithm to maximum extent. Chaotic maps are suitable for being applied on standard deviation utilizing logistic chaotic mapping, benchmark functions can be used to check performance of parameters as shown in Table 1.

Table 1. Deep survey on antenna design

Method	Reference
Power estimation in modern antenna system	Li and Mao [16]
A multi grid power balancing system using PSO	Tripathi *et al.* [17]
A single core current balancing and fault detection	Dhaliwal and Pattnaik [18]
A reactive power adjustment using GA	Iyampalam and Ganesan [19]
A critical insight energy differentiation	Thakare [20]
An advanced CPW antenna system	Gupta and Mathur [21]
An accurate low energy antenna design for 4G application	Varamini *et al.* [22]
Typical CPW: Fed antenna a design for low power circuits	Jawad *et al.* [23]

In 2006, Meharbian Lucas introduced iteration-based methods utilizing population as base. It is worth noting that genetic algorithm was first example of nature heuristic variety to be introduced by Holland in 1975 as an engineering technique. Ant colony optimization was postulated by Dorigo in 1996. PSO was earlier suggested by Kennedy and Eberhant in 1995. Artificial bee colony algorithm is credited to Bastruck and Karaboga in 2006. It is pertinent to note that cellular genetic algorithm was formulated by Kirley in 2002 while Emhirical evolutionary algorithm is attributed to Yuchi and Kim in 2005. In IWO, the weeds are assumed to be heavily grown which is a treat to useful plants. Sigma front characteristics of weed are and stability in adverse condition. Xing and Gao have worked on weed metaheuristic algorithm which compatibility and randomness are used to discover the optimal mathematical function. Chaos may be defined as chaotic behavior of nonlinear dynamic systems which are sensitive to initial conditions and can be described by deterministic algorithm. Chaos theory is considered as the science of surprises and unpredictability such that many evolutionary processes can be better understood by its implications. Other than being sensitive to initial conditions as explained by the Butterfly theory of Lorentz the property of ergodicity allows operation at higher speed. The dynamic property of chaos helps in search capacity while ergodicity helps in speed. It is pertinent to note that exploration gives in algorithm which discovers the required search area while exploitation is required for searching the most promising solution. Overall, Chaos is suitable for bounded nonlinear systems with ergodic/stochastic properties as found metaheuristic evolutionary methods. Maps used for chaos situation are either logistic, tent and sinusoidal map. Chaotic search and adaptive dispersion may be used with IWO to overcome IWO's drawbacks, since these approaches are better able to escape local minima. As a result, the precursor IWO is less vulnerable to premature convergence when using the CAIWO. Basing on the discussions of, sinusoidal map has been selected for the improvement necessary. For the map, the sinusoidal sequence is given by $\chi_{k+1} = a\,\chi_k(1-\chi_k)$ for the space [0, 1].

It is worth considering that the variation of the factor of chaos a can have effect on the success of CAIWO. To ensure proper choice of this parameter in case of sinusoidal pattern, a set of radiation patterns have been observed with respect to variation in the in a in the range of 1 to 3. The Figures 1 to 10 shows the change in the patterns. The variables are normalized in the range (0, 1) before applying the chaotic map. The variable X is transformed to (1).

$$X^{\leftharpoonup} = \frac{X - X_{min}}{X_{max} - X_{min}} \quad (1)$$

The sinusoidal sequence is used to transform $\underline{X}$ to a new value $X^{\leftharpoonup|}$. Then $X^{\leftharpoonup|}$ is back to the range (X_{max}, X_{min}) by (2).

$$x^{\leftharpoonup|} = x_{min} + x^{\leftharpoonup}(x_{max} - x_{min}) \quad (2)$$

Chaotic distribution is done using sinusoidal map. In the second step, each weed is sorted and ranked according to the fitness in the colony. In the third step, summing is done for the no. of current generation SD of each weed is calculated with respect to their ranking in the colony according to (3).

$$\sigma_j = \sigma_{current} * \frac{j}{p_{sum}} \quad (3)$$

Randomly dispersing fresh seeds with adaptive SD is then done. Using a sinusoidal map, fresh seeds are feast in the neighborhood of the parent new weed in the fourth stage. The better seed is preserved if the randomly dispersed one has a higher fitness rating. Otherwise, the haphazard hunt will continue.

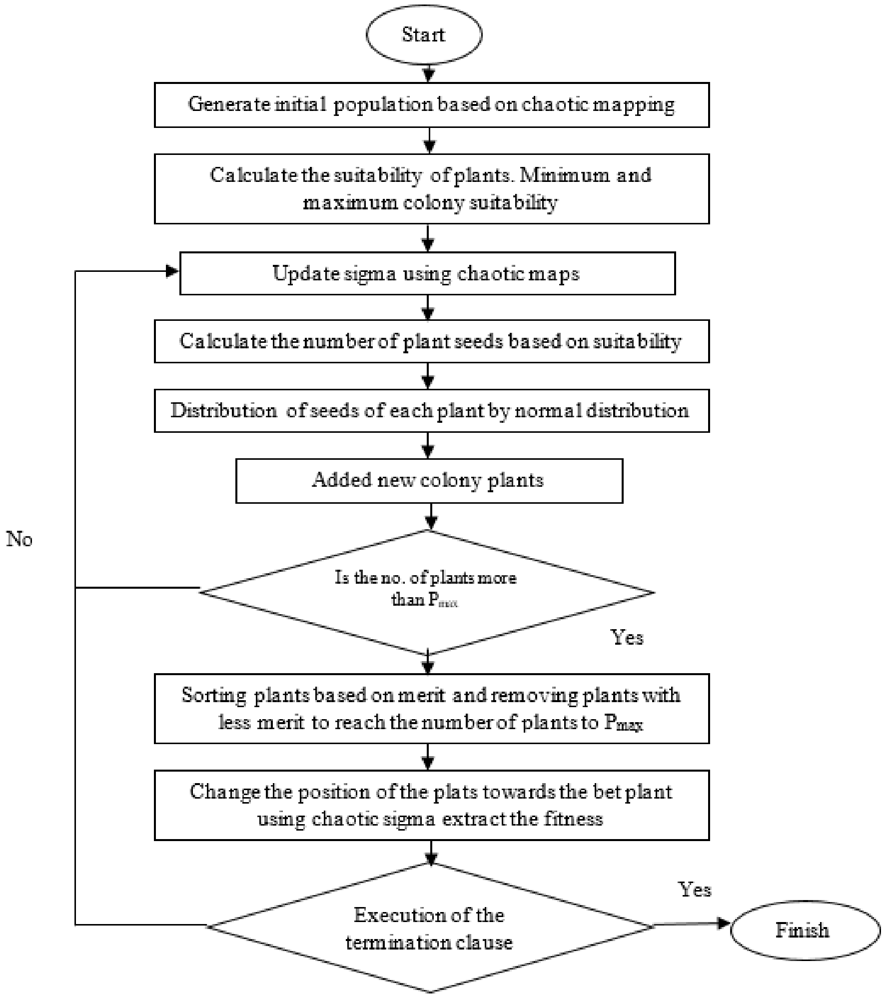

Figure 1. Flow chart of the CAIWO

To speed up convergence, this technique takes use of the supremacy of local search. The next stage is to rate the seeds. As a result, those with a lesser level of fitness are less likely to attain the maximum seeds p_{sum}. Step 3 is carried on until the supreme number of repetitions has been achieved or a requirement has been met in the final step.

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

When A=2.3 Adaptive Dispersion, the system's performance becomes chaotic. Lowest SD should be achieved by those weeds with the best fitness and the highest SD by those with the lowest fitness.

j = index of weeds sorted as per the fitness
p_{sum} = sum no. of weeds in the present generation
σ_j = SD of jth weeds to produce seed

The n-dimensional search space is seeded and randomly distributed with solutions. Number of seeds a plant can generate grows linearly from the lowest number for the plant with the weakest fitness to the highest number for the best-fitting plant in search [15]. SD is given by (5).

$$\delta_{cur} = \frac{(iter_{max} - iter)^n}{iter_{max}^n} \left(\delta_{initial} - \delta_{final}\right) + \delta_{final} \tag{5}$$

The algorithm operates with a high SD. As iteration number increased and SD value decreased, the search only be requested to neighborhoods around the local maximum or minimum for global optimal solution. New seed:

$$X_{son} = X_{parent} + SD = X_{parent} + radn(0,1) * \delta_{cur} \tag{6}$$

competitive Exclusion: limit is p_{sum}

CAIWO have suggested parameters estimation of chaotic systems. Using a chaotic map, new seeds are created by dispersing them to nearby weeds. They have not clarified on the formulation of the process. Furthermore, chaos not used in (1)-(4). In an effort to increase the algorithm's capacity to evade local optimums, we have developed an approach that reduces the algorithm's ability to exploit. The range of the normal distribution is wider than that of chaotic maps, although the maps are in the [0, 1] range. In comparison to normal chaotic maps, normal distribution is clearly superior in terms of exploitability. For the N-element circular array seen in Figure 1, the elements are arranged at non-uniform distances in the X and Y planes, and the array factor is utilized to characterize radiation pattern. The important factors are:

a_n – normalized amplitude excitation
ψ_n – The n^{th} element's phase excitation
φ_n – the n^{th} object's angular position
d_n – a space between two near neighbors
According to [ ], the peak of the array on φ_0 direction

$$\psi_n = -k_r \; cos\, cos\, (\phi_0 - \phi_n)$$
$$AF\,(\phi) = \sum_{N=1}^{N}.\,(a_n)\, e^{jk_r[coscos\,(\phi - \phi_n) - coscos\,(\phi_0 - \phi_n)]} \tag{7}$$

In order to identify the circular antenna array's electrical/geometrical construction in order to produce the radiation pattern through the lowest slew rate. Fitness Function:

$$F_{NULL} = |\,AF(\phi_{NULL1})| + |\,AF(\phi_{NULL2})|$$
$$F_{SLA} = \frac{1}{\Pi + \phi_{NULL1}} \int_{-\Pi}^{\phi_{NULL1}}.\,|AF(\phi)|\, d\phi + \frac{1}{\Pi - \phi_{NULL2}} \int_{\phi_{NULL2}}^{\Pi} |AF(\phi)|\, d\phi$$
$$F_{MSL} = |\,AF(\phi_{MSL1})| + |\,AF(\phi_{MSL2})| \tag{8}$$

ϕ_{NULL1} and ϕ_{NULL2} are the angles at null. ϕ_{MSL1} and ϕ_{MSL2} are angles where the minimum sidelobe level is obtained at lower band $[-\Pi, \phi_{NULL1}]$ too higher band $[\phi_{NULL2}, \Pi\,]$.

$$F = \omega_1 * F_{NULL} + \omega_2 * F_{SLA} + \omega_3 * F_{MSL} \tag{9}$$

In a circular array with non-uniformly spaced members, the degree of coupling varies. radiation in the plane of the antenna array is quite important. Taking minimum separation to be 0.5λ.

$$F_p = \sum_i^M.\,(0.5 - d_i)\, d_i < 0.5 \tag{10}$$

M is the total number of d_i lower than 0.5 in the issue.

A study of Planner Antenna Arrays

Step 1: chaotic mapping based on initial population
Step 2: Minimum and maximum arrays estimation
$$\psi_n = -k_r \; cos\, cos\, (\phi_0 - \phi_n)$$
Step 3: chaotic maps depending on sigma elements
$$F_{SLA} + \omega_3 * F_{MSL}$$
Step 4: distribution of normal distribution using p-max
$$\sum_i^M.\,(0.5 - d_i)\, d_i < 0.5$$
Step 5: pointing number of plants more than Pmax
$$|\,AF(\phi_{NULL1})| + |\,AF(\phi_{NULL2})|$$
Step 6: estimating plants with less merit to reach the number of plants to Pmax
$$F_{MSL} = |\,AF(\phi_{MSL1})| + |\,AF(\phi_{MSL2})|$$
Step 7: chaotic sigma extracts the fitness for power optimization
Step 8: Finish

4. RESULTS AND DISCUSSIONS

Antenna arrays are characterized by improved quality and augmented spectrum efficiency through the ability of forming steerable beam results in increased directivity. Antenna arrays that have a narrow bandwidth and low SLL can better regulate interference nulls. Other systems need to have their SLL kept at a minimum to prevent interference. Array pattern Analysis for different chaos factor:

Case 1:

The optimal value of c is 2.3 but even if we change it gives good results. 4G frequency and No of array elements, N=9 and element spacing is 0.75lambda shown in Figure 2. The Figure 3 is clealry explains about a nine element spcaing antenna desing in this chaotic facotrs are gratly analysied through array pattern.

The Figure 4 is clearly explains about nine elements spacing of chaotic factors, in this CAIWO and IWO are compared in this proposed design is attains more improvement. In Figure 5 C=1 this relates to the phase of convergence. In this Figure 3 C=1.5 and this is also chowing a phase of convergence. In Figure 4 C= 2.0 the periodicity starts. In this Figure 5 C=3 in this case a chaos factor is full above 3 also corresponding to phase of chaos.

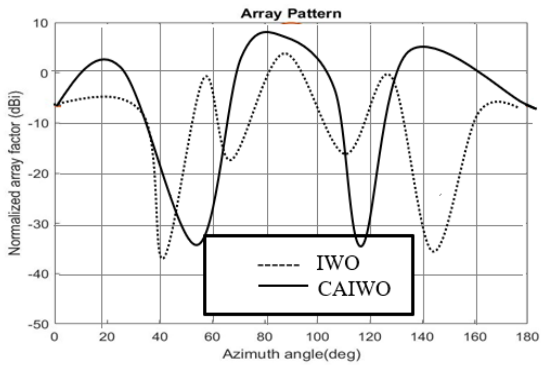

Figure 2. Radiation pattern for nine elements with spacing of 0.75λ and chaotic factor value of 2.3 as the critical point

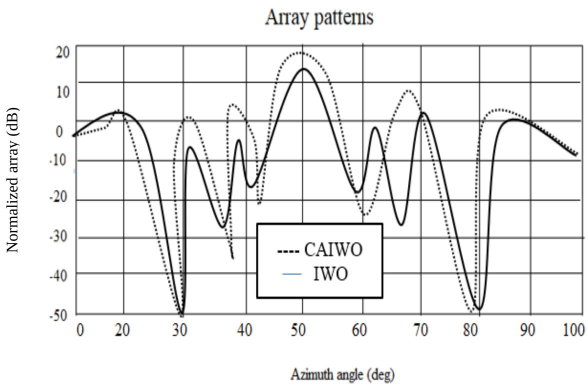

Figure 3. The chaotic factor is 2.0 for nine elements and spacing of 0.75λ

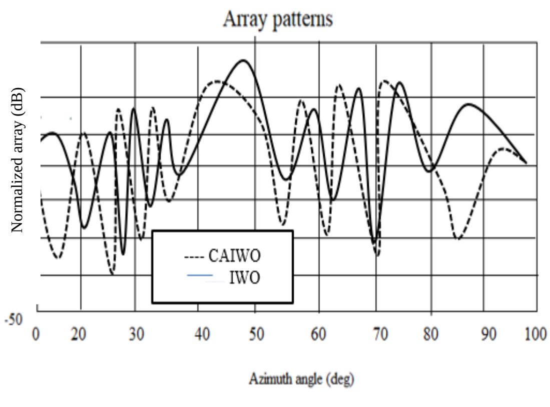

Figure 4. Chaotic factor is 3 for nine elements and spacing of 0.75λ

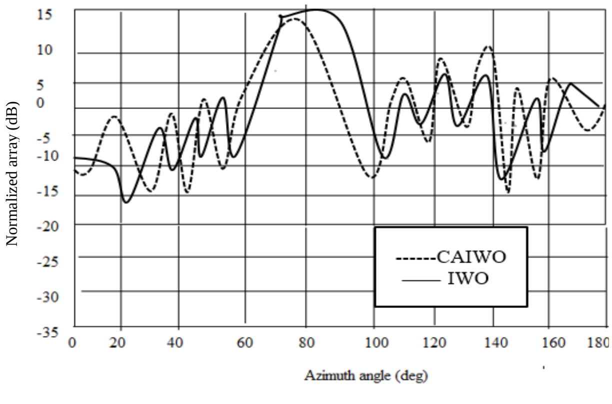

Figure 5. Chaotic factor is 3 for nine elements and spacing of 0.75λ

Case 2

For N=12, element spacing 0.75 lambda

The Figure 6 is explains about 12 element 9 elements array pattern, in this proposed design is outperforms methodology and compete with present technology. The Figures 7 and 8 explains about c=2.3 as well c=2.5 chaotic factors, here n=12 elements array factors design comparted CAIWO, IWO method attains good improvement. The critical point of 2.3 for chaos factor causes the map to enter a phase of disorder prior to the critical point, which begins with a phase of periodicity at chaos factor 2.

The chaos factor is 1.5 corresponding to convergence phase in Figure 8. In Figure 9 the chaos factor is critical point is just crossing preciosity. In Figure 8 chaos is 2.5 this just beyond the critical point. In Figure 8 the chaos factor 2 related to convergence. In Figure 10 C= 3 crossing the critical points are explained clearly.

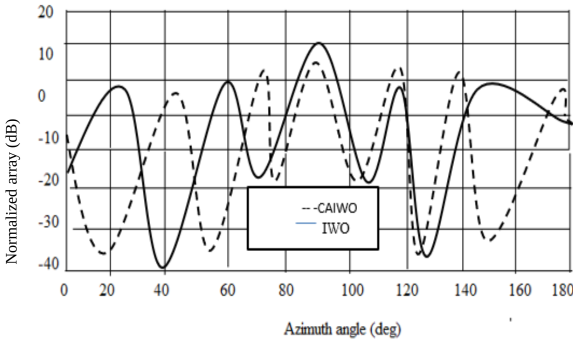

Figure 6. Chaotic factor is n=12 for nine elements and spacing of 0.75λ

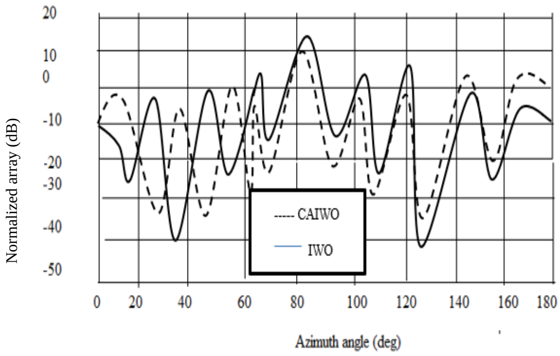

Figure 7. For C=2.3 chaotic factor is n=12 for nine elements and spacing of 0.75λ

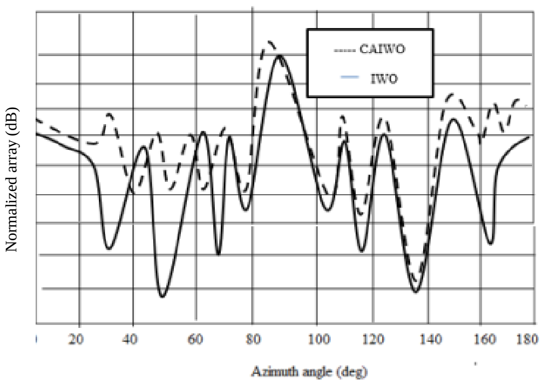

Figure 8. For C=2.5 chaotic factor is n=12 for nine elements and spacing of 0.75λ

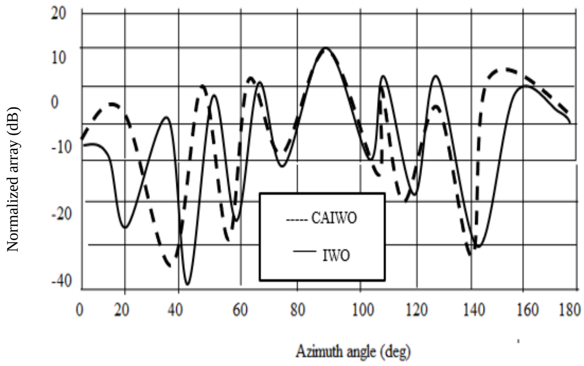

Figure 9. For C=2 chaotic factor is n=12 for nine elements and spacing of 0.75λ

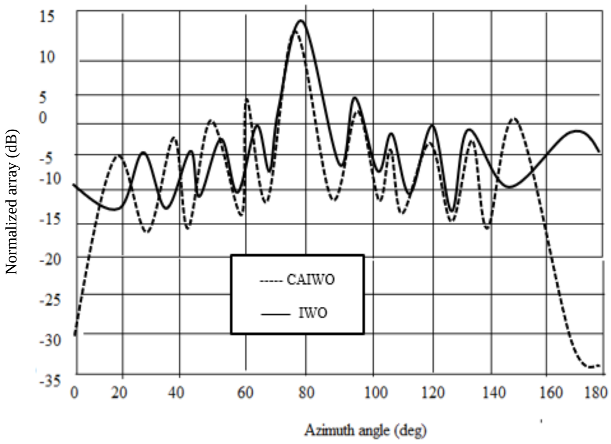

Figure 10. For C=3 chaotic factor is n=12 for nine elements and spacing of 0.75λ

5. CONCLUSION

CAIWO for radiation patterns of planner antenna arrays is determined by choice of the figurers of chaos the sinusoidal map is more effective having critical factor of 2.3 the study of radiation pattern has proved that varying the factor from 1 to 3 different condition of convergences periodicity and chaos exists. Convergence and chaos should have trade of proper optimization in which exploration (convergence) and exploration (chaos) can be properly balanced. MATLAB programming is used to investigate the effects of increasing chaos factors on the number of antenna elements and the distance between the antenna's emission patterns. There is no chaos below this threshold, only a phase of convergence. Convergence and chaos are useful trade-offs at these times. Variation of the chaos factor has been discovered to have an influence on the radiation factor of non-uniform planar antennas, resulting in periods of chaos convergence, which are necessary for making the trade-off between exploitation and exploration required in optimization. The primary goal of this research is to investigate invasive weed optimization in compression using modified chaotic adaptive invasive weed optimization. The study's main focus is on the influence of chaotic components suited for sinusoidal mapping for chaos in the context of antenna design.

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