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Amplitude only Low Side-lobe Level Array Pattern Synthesis using Cauchy mutated Invasive Weed Optimization

M. Hima Bindu, G. Navya, K. Veera Naga Lakshmi, P. Lakshman, Sai Santosh

Abstract: ***Antenna arrays are prominently used in satellites, radars mobile and wireless communication systems. Design of an antenna array with minimum side projections is the crucial component for noise free communications. There are various nature inspired optimization method have been suggested to optimize the peak side projections. To overcome low solution accuracy and low convergence rate, we are using newly developed Cauchy mutated invasive and optimization (CMIWO) to minimize the peak side projection levels in the radiation pattern. CMIWO is adapted to reduce the amplitude of the each antenna element. We have used 24, 32, and 64 element linear array of antenna for the synthesis. Based on the results the CMIWO produces suggestive reduction in peak side projections when contrasted with other array of antennas.***

Index Terms: Antenna array, peak side lobe level, Cauchy mutation, Invasive weed optimization.

I. INTRODUCTION

In wireless communication, satellite, mobile and radar communication, antenna arrays are used. Best signal quality. Best signal quality, and spectrum efficiency while improving directionality are provided by the antenna arrays. The effectiveness of antenna arrays can be decided by antenna arrays. For obtaining high directionality systems with narrow first null beam width (FNBW) are used. High directivity antennas are essential to maintain the nulls in the desired direction. A directionality of high and low side lobe levels should be required for the antennas to minimize intervention with other systems which are working with a frequency range. As the arrays with narrow beam width cannot give low side lobe levels, the Beam width and the low side lobe levels contradict each other. So without lowering either of the parameter the performance of the antenna cannot be enhanced. An antenna array with side lobe levels which are low can be designed by allotting fixed beam width and allotting zeros in the directions which is not desired.

According to the antenna array model, the spacing of elements of antenna, amplitude, and phase of the individual elements, the radiation pattern of the antenna array is described. To get the appropriate radiation pattern, over the past five decades, the work on synthesis of the antenna has been prominent. Optimization methods for each element have been studied in the literature survey by varying the input parameters. Various Optimization algorithms have been inspired from nature. For example, the genetic algorithm, particle swarm Optimization (PSO), ant colony Optimization. For the sketch and Optimization of the antenna arrays, these algorithms were successfully used. For the production of antenna arrays, Invasive Weed Optimization (IWO) method is used in present paper. IWO is a superior computational strategy introduced by Caros Lucas. For different Optimization problems in different areas, it has been successfully implemented. But, this the first time IWO is implemented in electro-magnetic applications. For reducing the distance between the linear antenna array elements, generate radiation pattern with low side projections and appropriate ways, this method is used.

II. LINEAR ANTENNA ARRAY

2N element Linear antenna array is positioned uniformly along as shown in the below figure.

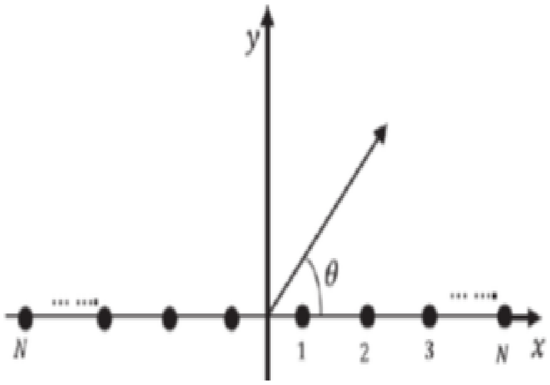

Figure 1: antenna array is placed uniformly with 2N elements

In azimuth plane, the array factor is given by

$$AF(\theta) = \sum_{n=1}^{N} A_n e^{j2\pi \left(d/_\lambda \right) \sin(\theta)}$$

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***** Correspondence Author

M. Hima Bindu*, ECE, Koneru Lakshmaiah Education Foundation (KLEF), Vijayawada, India. Email: maddali.himabindu@gmail.com
G. Navya, ECE, Koneru Lakshmaiah Education Foundation (KLEF), Vijayawada, India. Email: navyagutta412@gmail.com
K.Veera Naga Lakshmi, ECE, Koneru Lakshmaiah Education Foundation (KLEF), Vijayawada, India. Email: suryasushmakandula@gmail.com

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Here θ is the azimuth angle, d/λ= half the distance between elements which is distributed by amplitude, phase and wavelength of element n.

$A_n = I_n\, e^{\varphi_n}$

Where I_n= Excitation amplitude, φ_n= phase of element n.

III. INVASIVE WEED OPTIMIZATION

The Invasive Weed Optimization is motivated from the expansion of invasive weeds in nature based on botany and weed ecology. Using the invasive weed technique, it is proved that a powerful optimization can be obtained. In nature, by means of dispersal, weeds invade the spaces between crops in the fields. Those weeds turn into flowering plants and contribute seeds and this cycle continues. Thus, the weeds adapt to the environment and grow faster with better fitness in the field. In this way most of the field is occupied by the invasion of weeds. The new created weeds square measures indiscriminately adjoin the sector and grow to flowering weeds. Until the weeds reach the greatest number the process continues. Now, the weeds having more fitness will remain and turn out different weeds. The competition over those weeds will cause them to develop into more tailored and upgraded over time. The key terms described in the algorithm and elaborated in Table 1. Each respective agent, in the colony having the value of optimization variable is known as seed. In the colony all seeds grow into a flowering plant. Each plant is an individual agent after appraising one's performance. To grow a seed into a plant the agent's fitness is to be evaluated. The simulation of colonizing behavior of the seeds involves the following steps which are represented in the flow chart and discussed.

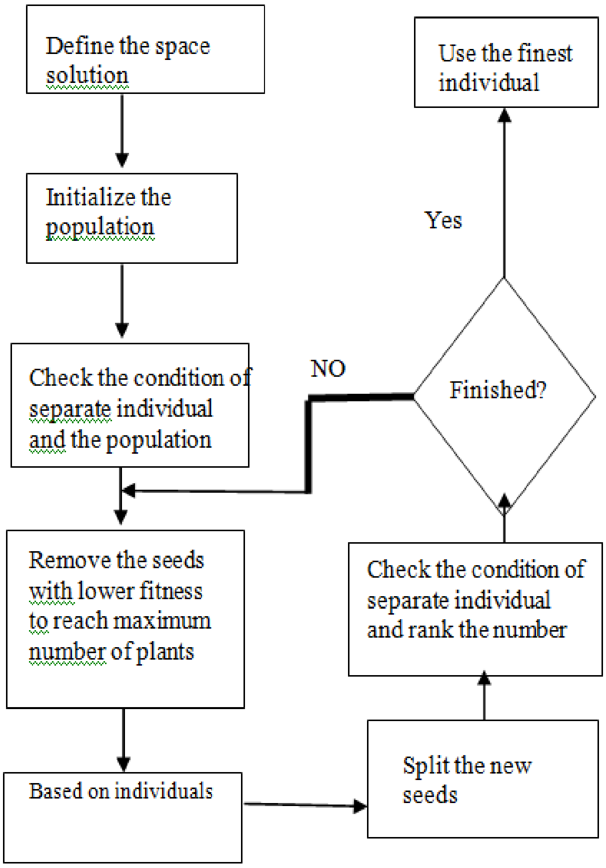

Figure 3: Flowchart showing the IWO algorithm

Agent/Seed	Value of optimized variable.
Fitness	The value which decides the strength of the seed.
Plant	An operator after estimating fitness value.
Colony	Group of complete operators of seeds
Count of all plants	The count of plants present in the group.
Highest number of plants	Highest number of plants which can yield new seeds in the group.

Table 1: Key terms used in IWO

Step 1: Maximum and minimum are assigned from the N dimensional solution space after selecting the parameters that are to be optimized.

Step 2: Finite number of seats are spread over so that each seed can take random position solution space. Each seed position in solution space is a basic solution with N values for N variables that are to be optimized.

Step 3: To represent the solution return values for each seed, a fitness function is defined.

Step 4: Flowering plants will be ranked according to the assigned fitness values before they produce new plants. Then with in the colony every flowering plant is made to provide seeds counting their rank. The amount of seeds that a plant delivers depends on the ranking and fitness value. And they will increase minimum attainable seed production to its highest. The seed which responds better are better fitting to the colony and accordingly yield more seeds. This step adds aspect to the algorithm by permitting all the plants to engage in production. This step adds a significant ability to the calculation by permitting all the plants to take part in the generation.

Step 5: All created seeds are spread over the arrangement space with the assistance of unarranged numbers with mean equivalent to the place of created plants and the standard deviation is expressed as

$$\sigma_{iter} = \frac{(iter_{max} - iter)^n}{iter_{max}{}^n}\left(\sigma_{initial} - \sigma_{final}\right) + \sigma_{final}$$

Where **iter**$_{\mathbf{max}}$ is maximum no of iterations and $\boldsymbol{\sigma}_{\mathbf{initial}},\boldsymbol{\sigma}_{\mathbf{final}}$ are standard deviations respectively and n is the modulation index. As number of iterations increases the standard deviation value decreases gradually around the local minima or local maxima to solve the finest solution.

Step6: As the past seeds discover their situation in such zone new seed started to grow and are positioned together with their parents. Plants with lower rank are eliminated with to arrive at greatest number of plants (P_{max})

Step7: The plants that endure that produce new seeds dependent on the ranking. The procedure repeated till either most extreme emphases are come to of wellness criteria is met.

Table2 Antenna Parameters

	Optimization of amplitude values	Distance between antenna elements	Non optimized PSLL	Optimized PSLL	Non optimized Beam width	Optimized Beam width
24 Element	0.999 0.9638 0.8954 0.8005 0.6872 0.5650 0.4427 0.3286 0.3286 0.4427 0.5650 0.6872 0.8005 0.8954 0.9638 0.9997	0.5λ	-13.43	-52.04	9.6	22
32 Element	1.0000 0.9885 0.9438 0.8871 0.8179 0.7435 0.645 0.5598 0.4685 0.3792 0.3012 0.2258 0.1610 0.1181 0.0740 0.0515 0.0515 0.0740 0.1181 0.1610 0.2258 0.3012 0.3792 0.4685 0.5598 0.6459 0.7435 0.8179 0.8871 0.9438 0.9885 1.0000	0.5λ	-13.35	-47.17	7.2	14.8
64 Element	1.0000 0.9993 0.9965 0.9926 0.9764 0.9451 0.9606 0.8776 0.8340 0.8540 0.7988 0.7159 0.7391 0.6735 0.6686 0.6011 0.5330 0.5207 0.4613 0.4101 0.3750 0.3312 0.3184 0.2544 0.2874 0.2051 0.1745 0.1248 0.1323 0.1287 0.1031 0.0870 0.0870 0.1031 0.1283 0.1323 0.1248 0.1745 0.2051 0.2874 0.2544 0.3184 0.3312 0.3750 0.4101 0.4613 0.5207 0.5330 0.6011 0.6686 0.6735 0.7391 0.7159 0.7988 0.8540 0.8340 0.8776 0.9606 0.9451 0.9764 0.9926 1.0000	0.5λ	13.27	-42.99	3.6	6.8

IV. OBJECTIVE FUNCTION

This fundamental point of enhancing is to get low side projection level in the radiation pattern by putting the components in various situations in the linear antenna array. To limit the side projection level, the target work is created as

$$\text{Fitness}=\max\left(20\log\frac{|AF(\theta)|}{\max|AF(\theta)|}\right)$$

θ ε side lobe region. (6)

V. NUMERICAL ILLUSTRATIONS

Three linear array configurations are considered A 24, 32 and 64 element linear antenna array is considered. Amplitude excitations are optimized by CMIWO to suppress PSLL.

Example 1: The main model delineates the side projection level for a24-component straight receiving wire exhibit in the region θ= [0°,85.2°] and θ=[94.8°,180°]. The acquired exhibit example utilizing the IWO enhancement is appeared in fig 4 alongside the uniform illuminated straight receiving wire array pattern. It is observed that there is an improvement in the lessening of the side projection level utilizing the IWO when contrasted with that of the respective optimized amplitude excitation estimations of the individual receiving wire components are appeared in the fig 1The transformative procedure for 24-component direct reception apparatus cluster by utilizing CMIWO is shown in fig 4.

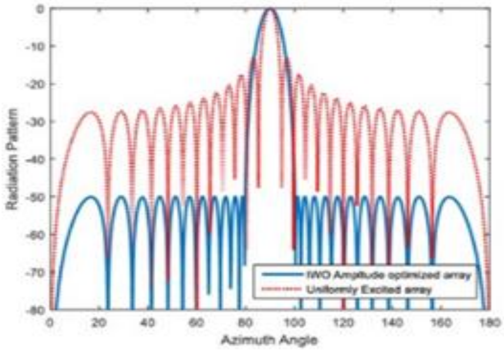

Figure 4: Examination between Radiation Pattern of 24 component direct radio wire exhibit utilizing CMIWO and Uniformly excited array

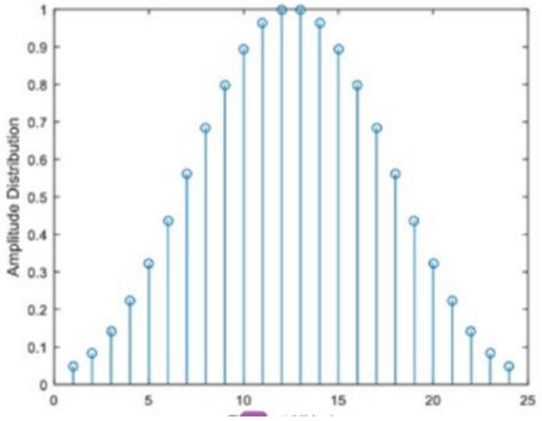

Figure 5: Amplitude level of 24 component direct radio wire cluster using CMIWO

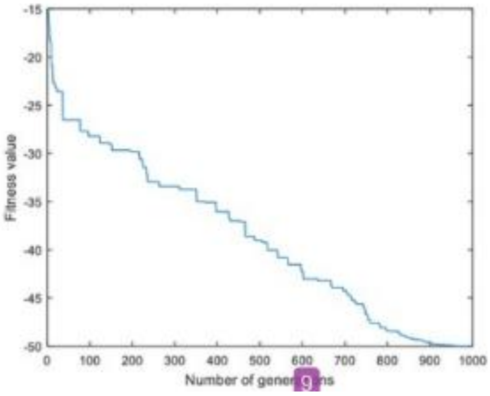

Figure 6: Union pattern of 24 component direct radio wire cluster using CMIWO.

Example 2:

The primary model shows the side projection level for a 32 component direct receiving wire in the region Ɵ=[0 °,86.4 °] and Ɵ=[93.6 °,180 °] . The got cluster utilizing the IWO activity is appear in fig 7 alongside the uniform lit up straight exhibit design. It is found that in comparison with the standard illuminated linear antenna array pattern, there is an increase in suppression of the side projection rate using the IWO. The respective optimized sufficiency excitation esteems for the individual radio wire components are depicted in fig 1.The corresponding optimized excitation amplitude values are shown for the individual antenna elements in fig 1.The developmental procedure for the 32-component straight reception apparatus exhibit by utilizing CMIWO is appeared in fig7.

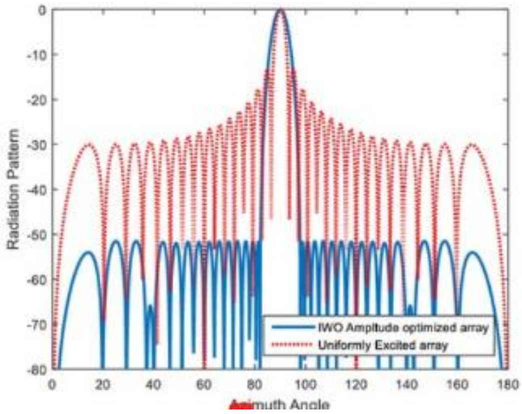

Figure 7: Comparison between Radiation Pattern of 32-component direct radio wire exhibit using CMIWO and uniformly excited array.

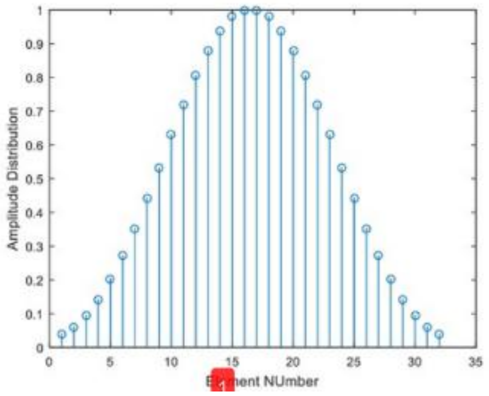

Figure 8: Amplitude levels of 32 component direct radio wire exhibit using CMIWO.

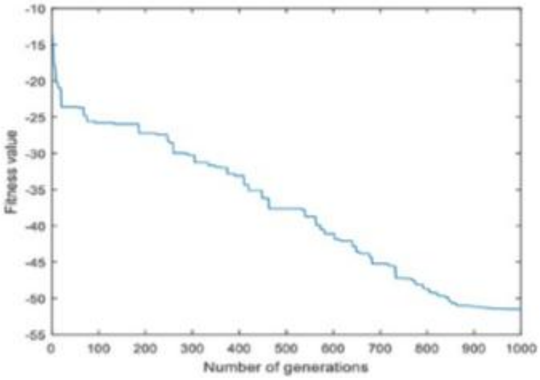

Figure 9: union pattern of 32 component direct radio wire exhibit using CMIWO

Example 3:

The first example indicates the side projection level for a 32 component direct receiving wire in the region Ɵ=[0 °,88.2 °] and Ɵ=[91.82°,180°]. The resultant direct receiving wire using the IWO optimization is shown in fig 10 together with uniform linear antenna array pattern. Using IWO, it is identified that there is an enhancement in the reduction of side projection level when analyze to the uniform linear antenna array pattern. The resultant optimized amplitude excited values for each of the antenna elements are shown in fig1. The developmental procedure for the 64-component straight receiving wire cluster by utilizing CMIWO is appeared in fig 10.

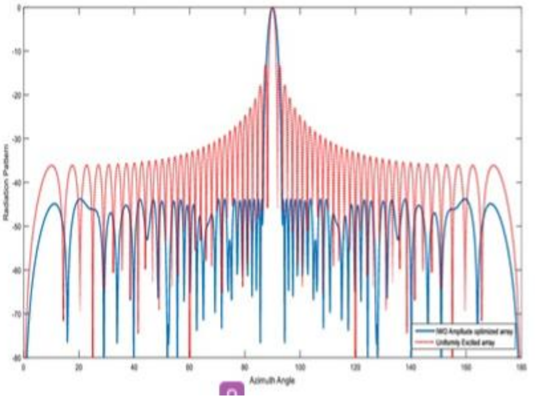

Figure 10: Comparison between Radiation Pattern of 64 component direct radio wire exhibit using CMIWO and uniformly excited array

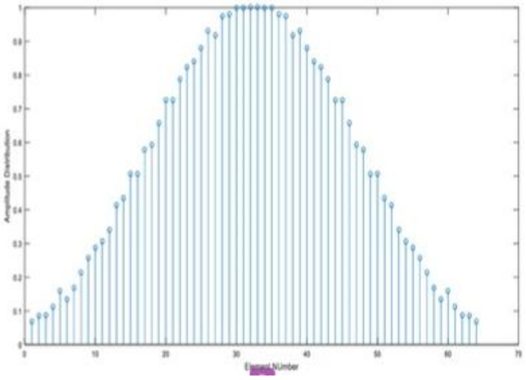

Figure 11: Amplitude levels of 64 component direct radio wire exhibit using CMIWO

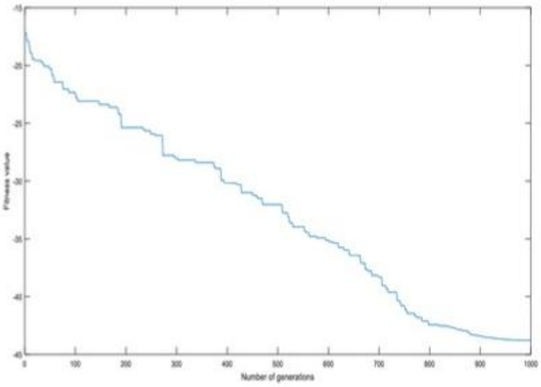

Figure 12: Convergence pattern of 64-element linear antenna array using CMIWO

VI. CONCLUSION

In this article, we proposed to synthesize direct receiving wire with minimum side projection levels a newly developed CMIWO. CMIWO is used to optimize the antenna elements amplitude excitations. A linear antenna array of 24, 32 and 64 were considered. The results obtained showed that CMIWO produces a significant decrease in level of the peak side lobe. A reduction of 52.04 dB is achieved for the 24 element linear antenna array by contrasting it with the uniformly illuminated linear antenna array. For the 32 linear arrays, CMIWO generates 47.17 dB while generating -13.23 dB with a standard illuminated array. A reduction of 42.99 dB is achieved for the 64 element direct receiving wire by contrasting it with the uniformly illuminated direct receiving wire. It very well may be closed from these outcomes that CMIWO gives great exactness of the arrangement and low union rate.

REFERENCES

1. Kumar BP, Branner GR. Design of unequally spaced arrays for performance improvement. IEEE Trans Antenna Propag 1999;47:511-23.
2. Khzmalyan D, Kondrat'yev AS. Phase-only synthesis of antenna array amplitude pattern. Int J Electron 1996;81:585-9.
3. Cen L, Yu ZL, Ser W. Linear aperiodic array synthesis using an improved genetic algorithm. IEEE Trans Anten Proapag 2012;60:895-902.
4. Ares-pena FJ, Gonzalez JA,Lopez E, Rengarajan SR.Genetic algorithms in the design and optimization of antenna array patterns.IEEE Trans Anten Propag 1999;47:506-10.
5. Lin C, Qing A-Y,Feng Q-Y. Synthesis of unequally spaced antenna arrays by using differential evolution IEEE Trans Anten Propag 2010;58:2553-61.
6. Eva RL ,Oscar QT .Linear array synthesis using an Ant colony optimization –based algorithm.IEEE Trans Anten propag 2007;49:70-9
7. Panda G, Pardhan PM, Majhi B. IIR system indentification using cat swarm optimization. Expert SystAppl 2011;38:12671-83.
8. Pappula L, Ghosh D. Linear antenna array sysnthesis using cat swarm optimization. AEU-Int J Electron Commun 2014;68:540-9.
9. Yu X, Gen M.Introduction to evolutionary algorithms.London:Springer;2010.
10. Chellapilla K. Combining mutation operators in evolutionaryprogramming. IEEE Trans Evol Comput 1998;2:91-6.
11. Deb K, Anand A, Joshi D. A computationally efficient evolutionary algorithm for real-parameter optimization. Evol comput 2002;10:371-95.
12. Zhan ZH, Zhang J, Li Y. Orthogonal learning particle swarm optimization. IEEE Trans Evol Comput 2011;15:281-95.
13. Lakshman Pappula,Debalina Ghosh. Synthesis of linear periodic array using Cauchy mutated cat swarm optimization. 1434-8411/2017, AEU, Elsevier.,

AUTHORS PROFILE

M. Hima Bindu currently pursuing Bachelor of Technology in Department of Electronics and Communication Engineering, Koneru Lakshmaiah Education Foundation (KLEF).
Gmail: maddali.himabindu@gmail.com

G. Navya currently pursuing Bachelor of Technology in Department of Electronics and Communication Engineering, Koneru Lakshmaiah Education Foundation (KLEF).
Gmail: navyagutta412@gmail.com

K.Veera Naga Lakshmi currently pursuing Bachelor of Technology in Department of Electronics and Communication Engineering, Koneru Lakshmaiah Education Foundation (KLEF).
Gmail: suryasushma@g

P.Lakshman
Gmail: lakshman7541@gmail.com

Sai Santosh
Gmail:saichinny@gmail.com