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# Synthesis of Linear Antenna Array Using Chaotic Optimization to Reduce the Side Lobe Levels

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***Abstract*— A novel approach symbolizing the principles of chaos [12] and its different application for optimization is new area to probe for research. The concept of local convergence and its symbolism to chaotic attractors is important to understand. A novel approach of having a population driven evolutionary optimization is then proposed combining the principle of chaotic attractors and edges for side lobe reduction of antenna array. The basic property of an antenna is to transmit and receive energy signal in one/all direction. This fundamental property is directivity. While designing an antenna, this is the most important factor that counts for an antenna performance. Hence, its optimization is always given importance. In this paper chos based optimization for antenna array is illustrated.**

***Keywords*—Antenna array, chos, cost function.**

## I. INTRODUCTION

With the advent of technology and recent developments in communication , wireless communication has reached to new level. Recent updates in wireless communication were not possible without application of smart antennas. Use of smart antennas is one of the vital characteristic that has led to third and fourth generation standard developments. However , smart antenna theory always driven by the Antenna array and so do the wireless communication. With antenna pattern synthesis there comes speed and robustness to the existing system thereby improvising transmission parameters [3]. Along with this radio wave propagation is a matter of research that accounts to faster and reliable transmission , since wireless is generated from the roots of radio communication. Radio communication was first came into existence in December , 1901 when Guglielmo Marconi successfully received the first transatlantic radio message [1]. The message under radio communication was letter 'S' which is considered as the most significant approach in developments of radio communication. This paper proposes a new generic evolutionary optimization technique for finding global minimal solutions. This approach looks at three critical issues in its operation. The first issue is the critical importance on initial conditions to the successful propagation of the population. The second is population dynamics which is included in the solutions, with regards to its interaction and behavior in the solution space. The population dynamics give rise to the third issue which is the attraction of variables within the population and its behavior which can be termed chaotic and random.

## II. ANTENNA ARRAY

An antenna array is a set of N spatially separated antennas. Most commonly antenna with N=5,10 elements are considered as array of antenna. An array of antenna can have number of elements which may include several thousand elements. . An antenna array is preferred over single antenna as it has ability to filtrate the intentional electromagnetic radiation in the air. Consider a linear array of n isotropic elements of equal amplitude and separated by distance d. The total field E at a far field point P in the given direction φ is given by,

$$E = 1 + e^{j\psi} + e^{2j\psi} + e^{3j\psi} + \cdots \ldots\ldots\ldots\ldots\ldots + e^{(n-1)j\psi} \quad \text{....1}$$

Where, ψ = total phase difference of the fields from adjacent sources. It is given by;

$$\psi = 2\pi\left(\frac{d}{\lambda}\right)\cos\phi + \alpha$$

α is the phase difference between excitation current of adjacent element of antenna array. The basic setup of an arbitrary antenna array is shown in Figure 1. The location of the nth antenna element is described by the vector dn , where
dn =[xn yn zn]

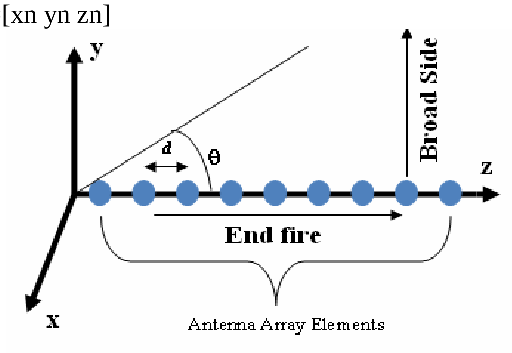


**Fig:1 Antenna Array**

The array factor for, N number of elements

$$AF = \sum_{n=1}^{N} E_n = \sum_{n=1}^{N} e_n{}^{jk}$$

Where
En $=e_n^{jK}$ and K= (nkdcosθ + βn) is the phase difference. βn is the phase angle. The antenna array can be used to:

- It increases the overall gain of the transmission.
- It helps to determine the direction of incoming signals
- Maximize the Signal to Interference Plus Noise Ratio (SINR)
- "Steer" the array so that it is most sensitive in a particular direction
- Cancel out interference from a particular set of directions

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- Provides diversity reception

## III. OPTIMIZATION USING CHOS PSO

The side lobe level reduction is the prime motive of the system. The optimization of the antenna current of each element is required to reduce the sidelobe level. Let the initial antenna current is [I1 I2 ……. In] , then the field due all antenna may be given as

**H=H1+H2+H3+……Hn;**

Where Hi is the magnetic field due to ith node of antenna array.

**Hi α Ii**

The normalized H will contain the information of beam pattern

As1 ,As2,As3…… is side lobe levels in beam pattern ,then the objective is minimize the cost function given as below

**C.F.=maximum([As1,As2,….]),**

Chaos states disorder and irregularities within a system. In order to enforce non-chaotic behavior, it is imperative to design a control of chaos. Two possibilities exist in order to accomplish a system that does not converge to an attractor or diverge to an edge .The first possibility is to detect whenever a chaotic system is about to arise and design a feedback system in order to bypass the chaotic region In order to find the global minima, the population needs not converge, but stay robust. Robustness is critical in order to map the solution space. Even when the objective function has converged, the ordering of the individual solutions is diverse. Therefore the approach proposed is to keep the solutions diverse throughout the evolution, by generating a distance between the solutions spread instead of the objective function of the solution. In order to do this, intelligence has to be incorporated within the solutions. The overriding approach is to incorporate population dynamics within the solutions in order to organize a feasible propagation approach. Chaos theory stipulates that the emergence of chaotic behavior is invariably linked to initial conditions of the system. When observing all EA's, it becomes clear that little attention is paid to the initial conditions like population. The overriding approach is to have a population created using random generation, which the search heuristic will guide towards the global minima. The fallibility of this approach is that a lot of emphasis The processes required to have a controlled propagation is described in the following sections. The methodology introduces the approach in terms of discrete optimization, specifically permutation based as a means to describe the different processes initial Population. The procedure of the Chaotic optimization is given below.

***1. Initial Population:*** An initial generation on N no. of population is generated randomly in the search space.

***2. Global Search:*** Random search is done for different values of current and a particular space is fixed.

***3. Population Propagation:*** Here the propagation of population from one search to another is done.

***4. Local Search:*** Systematic search is done in that space which is fixed by the global search and a best value is selected.

***5. Dynamic Replacement:*** In every iteration the last best value is compared with the previous best value if the current value is better than the previous the it is replaced by it, otherwise the previous value is kept intact.

***6. Generation:*** The solution iterates for N no. of generations and the top ranked value is printed as the final result.

## IV. SIMULATION RESULTS

The following parameters' are used for the system development in MATLAB,

| S. No. | Parameter | Value |
|---|---|---|
| 1 | Frequency of operation | 2.4 GHz |
| 2 | Type of antenna array | Broadside |
| 3 | No. of element | 5,10 |
| 4 | Output parameter | Directivity and side lobe level |

The simulation results of optimize and without optimize is shown below ,

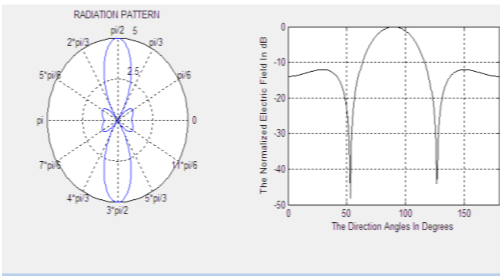


**Fig 2: Beam pattern without optimization 5 elements**

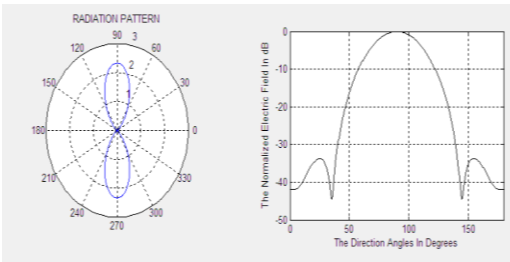


**Fig 3: Beam pattern using optimization 5 elements**

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More than 20 dB attenuation is achived with the optimization .

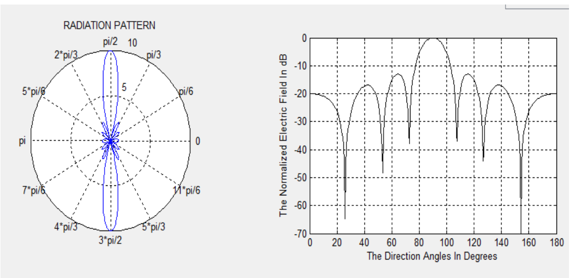


**Fig 4: Beam pattern without optimization for 10 elements**

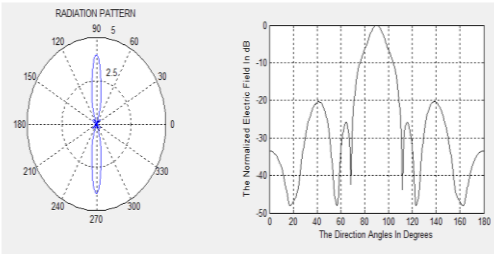


**Fig 5: Beam pattern using optimization for 10 elements**

More than 8 dB attenuation is achieved with the optimization for 10 antennas.

## V. CONCLUSION

In this paper chaotic optimization algorithm [12] method using MATLAB codes is used to obtain maximum reduction in side lobe level relative to the main beam. This work shows that the significant reduction of side lob levels with the use of optimization method gives better values of side lobes levels m. There is a significant reduction of -28dB to -38dB in this work.

## REFERENCES

[1] L. Coe, Wireless Radio: A History. New York: McFarland & Company, 2006.

[2] Donald Davendra et al, CHAOTIC OPTIMIZATION, Proceedings 21st European Conference on Modelling and SimulationIvan Zelinka, Zuzana Oplatková, Alessandra Orsoni ©ECMS 2007.

[3] Dale J. Shpak, “A method of optimal pattern synthesis of linear arrays with prescribed nulls”, IEEE transactions on antenna and propagation, Vol. 44, No.3, March 1996.

[4] Yahia Rahmat-Samii and Eric Michielssen, “Electromagnetic Optimization by genetic algorithms”, John Wiely & Sons, Inc, 1999

[5] Constantine A. BALANIS, “Antenna theory: analysis and design” Third edition, John Wiley & sons Inc., 2005.

[6] David A Coley, “An introduction to genetic algorithms for scientists and engineers”, World Scientific, 1999.

[7] Steyskal, H., R. A. Shore, and R. L. Haupt, “Methods for null control and their effects on the radiation pattern,” IEEE Trans. Antennas Propagat., Vol. 34, 404–409, 1986.

[8] Guney, K. and A. Akdagli, “Null steering of linear antenna arrays using modified tabu search algorithm,” Progress In Electromagnetics Research, PIER 33, 167–182, 2001.

[9] D. M. Pozar, Microwave and RF Wireless Systems, pp. 111-123, John Wiley and Sons, 2001.

[10] D.M. Pozar, Microwave Engineering, pp. 663-670, Addison-Wesley, 1990.

[11] www.macs.hw.ac.uk/~dwcorne/Teaching/bic_pso.ppt

[12] Chaotic optimization, Donald Davendra Godfrey Onwubolu Ivan Zelinka School of Engineering and Physics Faculty of Applied Informatics University of the South Pacific Tomas Bata University in Zlin Laucala Campus.