Design of Non-Uniform Circular Arrays for Side lobe Reduction Using Real Coded Genetic Algorithm

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ABSTRACT*:* The purpose of this paper is to design of non-uniform circular antenna arrays for maximal side lobe level reduction. The antenna array design problem consists of finding weights that provide a radiation pattern with maximal side lobe level reduction. Real Coded Genetic Algorithm (RCGA) are very appropriate tools to search for the best antenna models. The effectiveness of Real Coded Genetic Algorithm (RCGA) for the design of non-uniform circular arrays is shown by means of experimental results. Experimental results reveal that design of non-uniform circular antenna array provides a considerable side lobe level reduction with respect to the uniform case.

Keywords: Side lobe level, Array factor, Genetic algorithm, Circular antenna array

I. INTRODUCTION

The design of circular antenna arrays [1] finds application in areas as mobile and wireless communications systems. Generally speaking, the problem of designing antenna arrays is characterized by different and conflicting requirements (beam width, side lobe level, directivity, noise sensitivity, robustness) to be satisfied. In this paper a design criterion is considered to evaluate the performance of circular array for minimum side lobe level [2].

Real Coded Genetic Algorithm (RCGA) technique [3] [4] [8] has been fairly successful at designing linear antenna arrays. However, array configurations in which the elements are placed in a circular ring are of great interest. They have applications in radio direction finding, air and space navigation, radar, and other systems. A real Coded Genetic Algorithm (RCGA) technique is applied to design of non-uniform circular antenna arrays. The method of Real Coded Genetic Algorithm (RCGA) is used to determine an optimum a set of weights that provide a radiation pattern with maximal side lobe level reduction.

II. ANTENNA DESIGN

A. Problem Statement

Design of a Non Uniform circular array that provide a radiation pattern with maximal side lobe level reduction. Real Coded Genetic Algorithm is applied to design of Non-Uniform circular antenna arrays [6]. The method of Real Coded Genetic Algorithm is used to determine an optimum a set of amplitude excitation weights to provide a radiation pattern with maximal side lobe level reduction. Initially Uniform circular radiation pattern [5] is generated for number of elements N=10 and the sidelobe level for that is calculated.

Design a Non-Uniform circular for N=10 and 20 with maximum SLL for different set of amplitudes. These different set of element amplitude excitations are generated by using **Real Coded Genetic Algorithm** *[7]*.
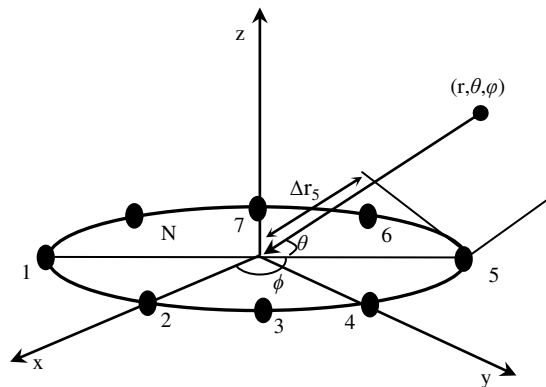

Fig.1: Geometry and notations used for non-uniform circular antenna array

B. Array Factor Analysis

Consider a circular antenna array of N antenna elements uniformly spaced with a distance 'd' on a circle of radius *a* in the *x–y* plane as shown in below figure 1. If the N elements in the circular antenna array are taken to be isotropic sources, the radiation pattern of this array can be described by its array factor. Let the objective function is sidelobe level. The array factor for the circular array in the *x–y* plane in figure 1 is given by

$$AF(\theta, I) = \sum_{n=1}^{N} I_n \, e^{j[ka\cos(\theta - \varphi_n) + \alpha_n]}$$

Where

I_n = Excitation of nth element

N= no.of elements in circular ring

$k = \dfrac{2\pi}{\lambda}$ phase constant

$a = \dfrac{Nd}{2\pi}$ where $d = \dfrac{\lambda}{2}$

Then $ka = \dfrac{N}{2}$

$\varphi n = \dfrac{2\pi n}{N}$ Where n = 1,2,…….N

$\alpha n = -ka \cos(\theta 0 - \varphi n)$

θ_0 = maximum radiation angle
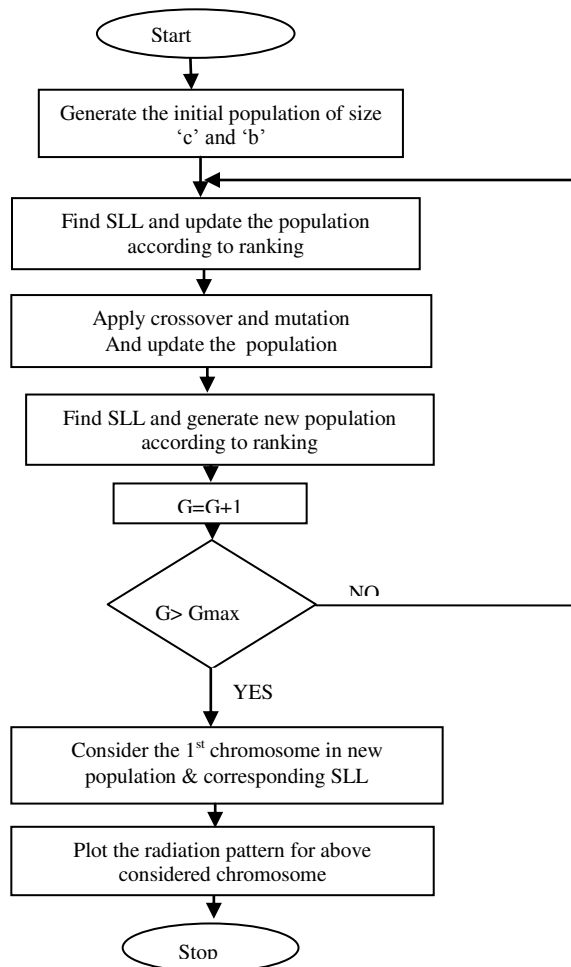
C. Flowchart

Fig.2: Flow chart representation of Real Coded Genetic Algorithm

The computed amplitude excitation coefficients, corresponding Sidelobe Levels and Beamwidths are presented in Table I.

Table I
Amplitude excitation coefficients, SLL, FNBW and HPBW

Lenth of Array(N)	Amplitude Dstributions($I_1, I_2, I_3, \ldots\ldots, I_{N-1}\ I_N$)	SLL(dB)	FNBW	HPBW
10	0.8598 0.5019 0.6310 0.6435 0.9641 0.6651 0.6835 0.9778 0.9386 0.8652	-8.5756	60^0	30^0
20	0.7950 0.5568 0.7007 0.8349 0.4427 0.7667 0.7709 0.5445 0.7294 0.8721 0.8340 0.5465 0.6864 0.7983 0.3634 0.6367 0.6465 0.5807 0.8279 0.7282	-9.0126	28^0	14^0

III. RESULTS

A uniform circular array is considered and its field pattern is computed numerically and represented in figure 3.For N=10 and 20 the amplitude excitation coefficients are synthesized by using Real Coded Genetic Algorithm. By using the amplitude excitation coefficients, non uniform circular array patterns are numerically computed and their respective Radiation patterns are presented in figure 4 and figure 5.
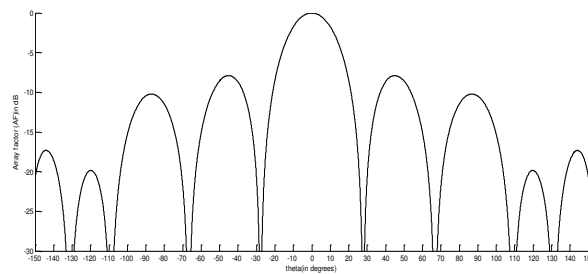

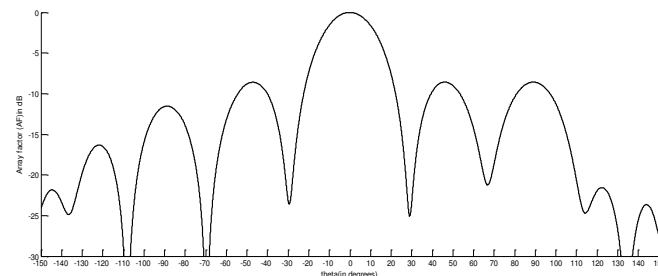Fig.3: Radiation pattern of Uniform Circular Array for N=10

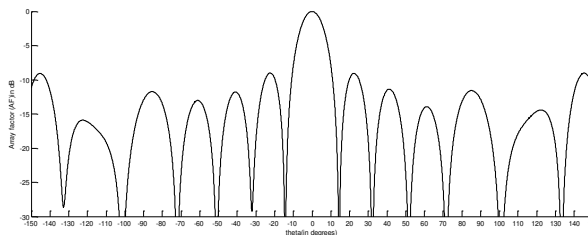Fig.4: Radiation pattern of circular array for N=10 using Real Coded Genetic Algorithm

Fig.5: Radiation pattern of circular array for N=20 using Real Coded Genetic Algorithm

IV. CONCLUSION

The paper presents the design of non-uniform circular antenna arrays to generate a radiation pattern with maximal side lobe level reduction. Experimental results reveal that design of non-uniform circular antenna arrays using the method of Real Coded Genetic Algorithm (RCGA) provides a considerable side lobe level reduction with respect to the uniform case. It is evident from results, that sidelobe level (SLL) and Beamwidths are reduced with increase of the number of elements in array.

REFERENCES

[1]. Constantine A.Balanis "*Antenna Theory analysis and design*" 3rd ed., Wiley India, 2005.

[2]. Marco A. Panduro, Aldo L. Mendez, Rene Dominguez, Gerardo Romero "Design of non-uniform circular antenna arrays for side lobe reduction using the method of genetic algorithms" *Int. J. Electron. Communications. (AEÜ)* pp 713 – 717,2006.

[3]. Bray MG, Werner DH, Boeringer DW, Machuga DW. "Optimization of thinned aperiodic linear phased arrays using genetic algorithms to reduce grating lobes during scanning" *IEEE Trans Antennas Propagation*, pp:1732–1742, 2002.

[4]. Haupt R. "Thinned arrays using genetic algorithms" *IEEE Trans Antennas Propagation* ,pp 993–999, 1994

[5]. Yan KK, Lu Y. "Sidelobe reduction in array-pattern synthesis using genetic algorithm" *IEEE Trans Antennas Propagation*; pp1117–1122,1997.

[6]. Panduro MA, Covarrubias DH, Brizuela CA, Marante FR. "A multi-objective approach in the linear antenna array design" *AEU Int. J Electron Commun*ications;pp:205–12, 2005.

[7]. Lommi A, Massa A, Storti E, Trucco A. "Sidelobe reduction in sparse linear arrays by genetic algorithms" *Microwave Opt Technol Letter*; pp: 194–196, 2002.

[8]. Golberg DE. "*Genetic algorithms in search, optimization, and machine learning*". Massachusetts: Addison-Wesley; 1989.

BIOGRAPHY

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