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# Design of Non-uniform Scanned Beam Circular Array Antenna

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## ABSTRACT

*In this paper, the synthesis of circular antenna array (CAA) is demonstrated using meta-heuristic algorithm known as social group optimization algorithm (SGOA). The non-uniform amplitude distribution is determined using the SGOA and the patterns produced are SLL optimized along with the main beam scanned to $15^0$. The results are analysed in terms of amplitude distribution and radiation patterns. The simulation is carried out using MATLAB.*

***Key*words-***CAA, SGOA, amplitude distribution.*



## I. INTRODUCTION

Antennas with a given radiation pattern may be arranged in a pattern line, circle, plane, etc.) to yield a different radiation pattern. Antenna array is a configuration of multiple antennas (elements) arranged to achieve a given radiation pattern. Simple antennas can be combined to achieve desired directional effects. Individual antennas are called elements and the combination is an array. Circular arrays are less sensitive to mutual coupling as compared to linear and rectangular arrays since they do not have edge elements. They can be used for beam forming in the azimuth plane for example at the base stations of the mobile radio communication systems as the components for signal processing.

An array of antennas may be used in a variety of ways to improve the performance of a communications system. Perhaps most important is its capability to cancel co channel interferences. An array works on the premise that the desired signal and unwanted co channel interferences arrive from different directions. The beam pattern of the array is adjusted to suit the requirements by combining signals from different antennas with appropriate weighting. An array of antennas mounted on vehicles, ships, aircraft, satellites, and base stations is expected to play an important role in fulfilling the increased demand of channel requirement for these services

Since antenna array design problems are generally in a multimodal form, it is at high possibility that most of the classical optimization algorithms are caught up in a local-solution. Evolutionary and meta-heuristic algorithms can sub-optimally solve a multimodal numerical optimization problem defined by using an objective function without needing the derivative of the relevant problem. Thus, in the present work, application of heuristic algorithms like social group optimization is presented.

## II. FORMULATION

The elements are nonuniformly spaced on a circle of radius r in the Y-Z plane. The elements are assumed to be isotropic sources so that the radiation pattern of the array can be described by

its array factor. The geometry of an N element circular antenna has been shown in Fig. 1.

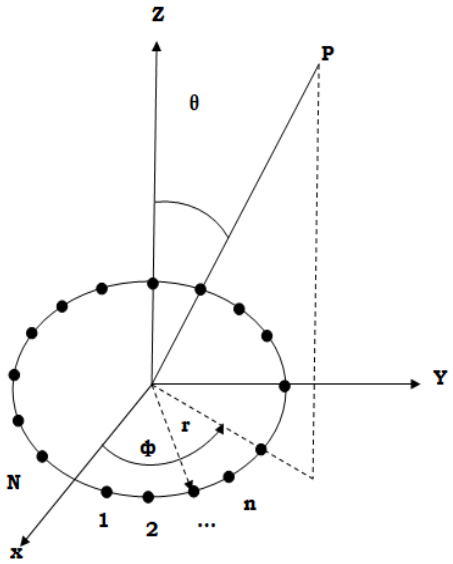


Fig. 1: Geometry of isotropic Circular Array

The array factor in the Y-Z plane can be written as

$$A_F(\theta) = \sum_{n=1}^{N} A_n \exp\left[jka\cos(\theta - \phi_n + \alpha_n)\right] \quad (1)$$

Where,

$$ka = \sum_{i=1}^{N} d_i \quad (2)$$

$$\phi_n = \frac{\left(2\pi \sum_{i=1}^{n} d_i\right)}{\left(\sum_{i=1}^{N} d_i\right)} \quad (3)$$

$$\alpha_n = -ka\cos(\theta_o - \phi_n) \quad (4)$$

Thus the following fitness function is used.

$$\text{Fitness} = \text{Max}_{\theta \in S}\left|\frac{P(\theta)}{P(\theta_o)}\right| \quad \text{subject to } F \le F_u$$

## III. RESULTS

The results of simulation experimentation for different sized circular arrays are presented in this Section with their main beam steered to $15^0$ in order to represent the DOA of desired signal. Further, the simulation is carried for N=20, 30 and 50 element circular array antenna in which all the elements are array periodically spacing on the circumference of the circle.

The results are presented in terms of radiation patterns and the amplitude distribution as determined by the SGOA. The radiation pattern plots and the non-uniform distribution are presented in Fig.2 through Fig.7 as follows. The radiation pattern plot for N=20 is as shown in Fig.2 where the main beam is steered to $15^0$ and the corresponding SLL is optimized to below -25dB. Similarly, the radiation pattern for N=30 and N=50 are as shown in Fig.4 and Fig.6 respectively and the corresponding non-uniform amplitude distribution is as shown in the stem plots presented in Fig.5 and Fig.7 respectively.

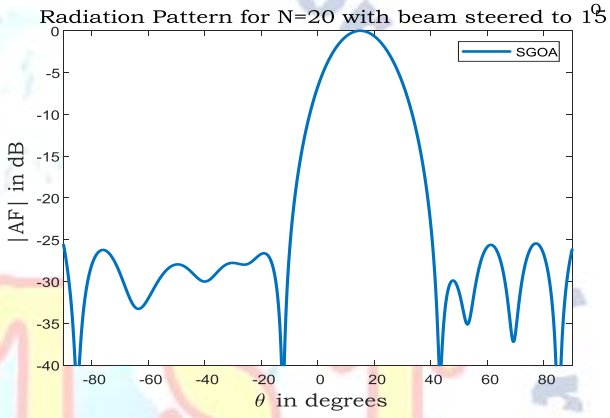


*Fig.2: Radiation pattern of circular array for N=20*

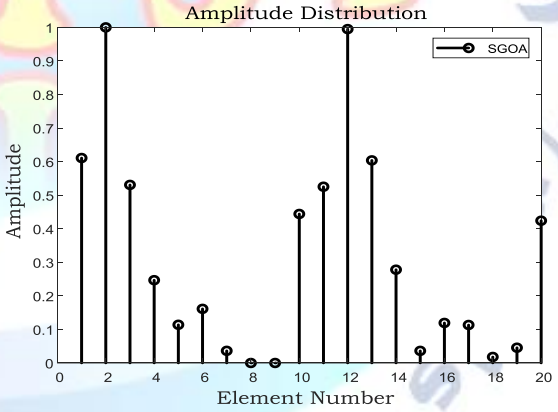


*Fig.3: Amplitude distribution determined by SGOA for N=20*

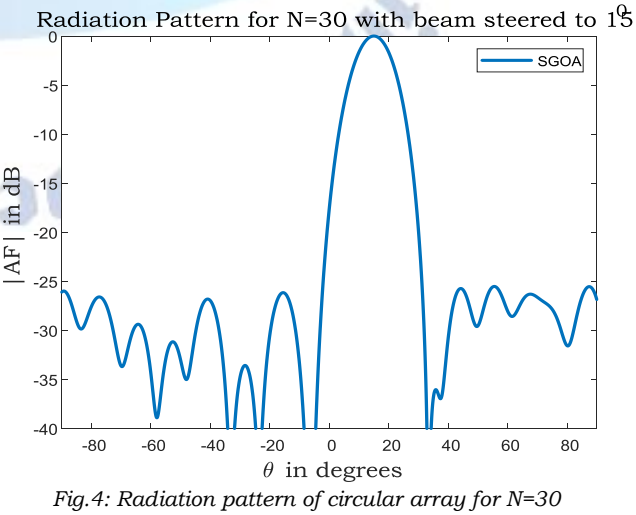


*Fig.4: Radiation pattern of circular array for N=30*

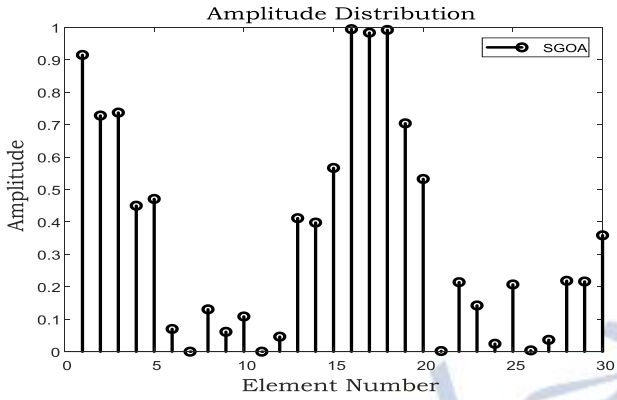


*Fig.5: Amplitude distribution determined by SGOA for N=30*

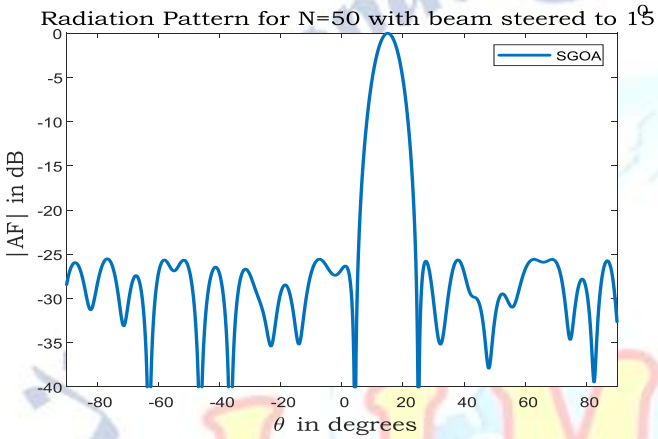


*Fig.6: Radiation pattern of circular array for N=60*

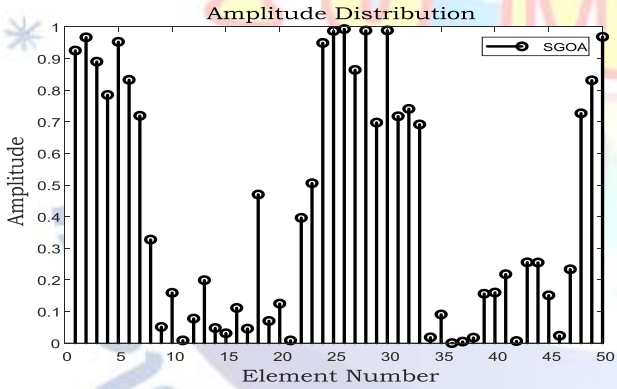


*Fig.7: Amplitude distribution determined by SGOA for N=50*

## IV. Conclusion

The circular array antenna with beam steered to $15^0$ is successfully designed using SGOA. The SGOA is implemented to determine the non-uniform amplitude distribution of circular array with the objective of SLL optimization along with scanned beams for the applications of beamforming.

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