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INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

PERFORMANCE ANALYSIS OF THE MFO BASED BEAM STEERING FOR CIRCULAR ANTENNA ARRAY

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DOI: 10.5281/zenodo.805367

ABSTRACT

The basic property of an antenna is to transmit and receive energy signal in one/all direction. This fundamental property is directivity. While antenna designing an antenna, this is the most important factor that counts for an antenna performance. Hence, its optimization is always given importance. There are so many processes available that are used for optimization of an antenna pattern yet no one out of them provides satisfactorily results by reducing all noise parameters. Depending upon, there are a number of experimentation tools and theories available to optimize the antenna array design , however at timeswith manual approach they becomes complicated and time consuming. In this paper Moth Flame optimization (MFO) based for antenna array is illustrated.

KEYWORDS: Smart Antenna, MFO, directivity, Beam Steering, etc.

INTRODUCTION

The prominent development as it has enabled antenna structure to receive transmits information from any direction without any structure movement. Moreover, now antenna systems could receive the energy from the wanted direction while rejecting energy or information signal from all other direction that are basically contributing to noise. Now, the antenna arrays could be used to mitigate intentional interference or unintentional interference directed toward the communication system. Intentional interference here refers to jamming while unintentional interference refers to radiation from other source that is not meant for the system in communication. With more research in the field to optimize and improvise the antenna array performance, there came adaptive antenna concept. These antenna array were capable of adapting signal radiations pattern as per the environment factors they are operating in, a one more milestone in wireless communication. Because of all tremendous advancements wireless communication resulting with updates in antenna array , numerical computing, optimization of the element positions in an antenna array (for various situations) is now up to the mark and are referred as smart Antennas. Smart antenna systems basically act as the switched beam type, communicate directionally by forming specific antenna beam patterns thereby selecting one of the weighted combinations of antenna outputs with the greatest output power in the remote user's channel. But the transmission reception is not 100 percent here as there dominates noise, circuit power, and other environmental factors. So , when a smart antenna directs its main lobe with enhanced gain in the direction of the user (information intended receiver), it forms side lobes as well thereby segregating the gain in areas of minimum gain in direction away from the main lobe gain. Thus, to yield maximum gain in transmission, side lobe level needs to be as minimum as it can be. For this purpose, the concept of different switched beam and adaptive smart antenna systems is taken that controls the lobes and nulls with varying degrees of accuracy and flexibility. Traditional methods for these are used in general synthesis but if the radiation pattern has increased number of constraints then other numerical methods are used. For solution employed on large arrays , the problem is more critical and the solution space is very large so exhaustive checking of all possible phase-amplitude excitations and/or element positions is very difficult for the methods based on deterministic rules. The most important benefit of using MFO is that it can be used efficiently where traditional methods becomes complex and with fast convergence. Pattern generated using this method can be integrated much better than that by using the traditional method and other optimization techniques for the more element number or pattern in the form of the function, and when the more complex the more obvious, the superior of the genetic algorithm performance.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

A smart antenna technology can achieve a number benefits like increase the system capacity, greatly reduce interference, increase power efficiency. In the following section we review on the smart antenna technology with the help of simulation by using MATLAB.

RELATED WORK

M. M. Abusitta, in this paper, a simple switching process is employed to steer the beam of a vertically polarised circular antenna array. This is a simple method, in which the difference resulting from the induced currents when the radiating/loaded element is connected/disconnected from the ground plane. A time modulated switching process is applied through particle swarm optimization. A simple procedure of beam steered of ring antenna array using time modulated switching process has been presented. The method is quite simple and it could be a good candidate to replace the loaded reactive steered antenna array [1].

M. Khodier, in this paper, the proposed linear and circular arrays are optimized using the particle swarm optimization (PSO) method. Also, arrays of isotropic and cylindrical dipole elements are considered. The parameters of isotropic arrays are elements excitation amplitude, excitation phase and locations, while for dipole array the optimized parameters are elements excitation amplitude, excitation phase, location, and length. PSO is a high-performance stochastic evolutionary algorithm used to solve N-dimensional problems. The method of PSO is used to determine a set of parameters of antenna elements that provide the goal radiation pattern. The effectiveness of PSO for the design of antenna arrays is shown by means of numerical results. Comparison with other methods is made whenever possible. The results reveal that design of antenna arrays using the PSO method provides considerable enhancements compared with the uniform array and the synthesis obtained from other optimization techniques. For practical implementation of circular array, a circular dipole array is optimized to minimize the maximum SLL. The method of moments is used to determine the current distributions on the dipoles. The optimized parameters are elements excitation amplitude, excitation phases, locations and lengths. The results show that minimum SLL can be achieved by optimizing these parameters using the PSO method [2].

ANTENNA ARRAY

I. Moth Flame Optimization

In the proposed MFO algorithm, I assumed that the candidate solutions are moths and the problem's variables are the position of moths in the space. Therefore, the moths can fly in 1-D, 2-D, 3-D, or hyper dimensional space with changing their position vectors. Since the MFO algorithm is a population-based algorithm.
It should be noted here that moths and flames are both solutions. The difference between them is the way we treat and update them in each iteration. The moths are actual search agents that move around the search space, whereas flames are the best position of moths that obtains so far. In other words, flames can be considered as flags or pins that are dropped by moths when searching the search space. Therefore, each moth searches around a flag (flame) and updates it in case of finding a better solution. With this mechanism, a moth never lose its best solution.
I chose a logarithmic spiral as the main update mechanism of moths in this paper. However, any types of spiral can be utilized here subject to the following conditions:

- Spiral's initial point should start from the moth
- Spiral's final point should be the position of the flame
- Fluctuation of the range of spiral should not exceed from the search space

Considering these points, I defined a logarithmic spiral for the MFO algorithm as follows:

$$S(M_iF_i) = D_i . e^{bt} . \cos(2\pi t) + F_j \qquad (1)$$

where *Di* indicates the distance of the *i-th* moth for the *j-th* flame, *b* is a constant for defining the shape of the logarithmic spiral, and t is a random number in [-1,1].
D is calculated as follows:

$$D_i = |F_j - M_i|$$

With the above equations, the spiral flying path of moths is simulated. As may be seen in this equation, the next position of a moth is defined with respect to a flame. The *t* parameter in the spiral equation defines how much the next position of the moth should be close to the flame (*t = -1* is the closest position to the flame, while *t = 1*shows the farthest). Therefore, a hyper ellipse can be assumed around the flame in all directions and the next position of the moth would be within this space. Spiral movement is the main component of the proposed method because it dictates how the moths update their positions around flames. The spiral equation allows a moth to fly "around" a flame and not necessarily in the space between them. Therefore, the exploration and

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

exploitation of the search space can be guaranteed. The logarithmic spiral, space around the flame, and the position considering different t on the curve are illustrated as follows:

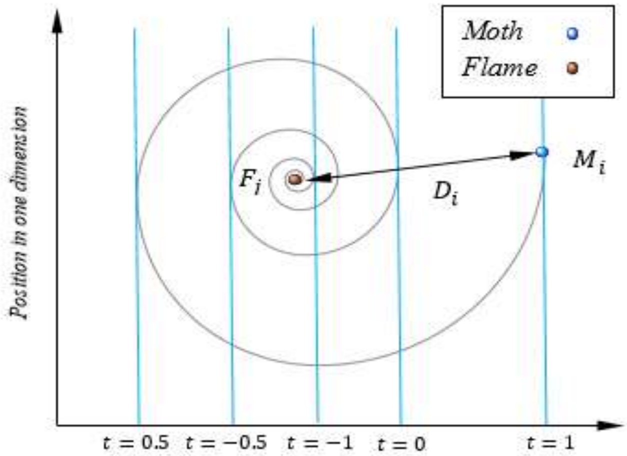

Fig. 1 Moth Flame Algorithm

DOA ESTIMATION & BEAMFORMING

Since most RF antennas amplifiers, mixers, filters and ADC technologies have reached a mature state, accurate estimation of the angle of arrival of signals impinging an array of antennas becomes the most important parameter regarding the performance of an adaptive array. Assuming a linear and isotropic transmission medium, multiple impinging wave fronts can be modeled as the superposition of these wave fronts impinging on the array. It is therefore necessary for the DOA estimation algorithm to be able to resolve impinging and often fully coherent wave fronts into their respective DOA's. Many DOA estimation algorithms exist, but only a few have found use in smart antennas i.e. conventional methods, linear predict ion methods, eigen structure methods and estimation of signal parameters via Rotational invariance techniques. All these methods are based on the digital beamforming antenna array. Signals received by individual antenna elements, are down converted to base band signal then they are digitized and fed into a digital signal processing chip where the DOA estimation algorithm is executed. In this paper we take a brief review on the DOA estimation using PM algorithm for finding the PL and LM S algorithm uses the estimate of the gradient vector fro m the available data. LM S algorithm is important because of its simplicity and ease of the computation.

The delay and sum beamformer is attractive because of its simplicity and ease of implementation. The limiting factor method is that though it can steer its main beam it has no control over its side lobes. The solution to this problem is the null steering beamformer also minimize the signal to interference ratio and for direction of arrival estimation and beamforming would like to simulate Estimator and beamformer as follows fig.2.

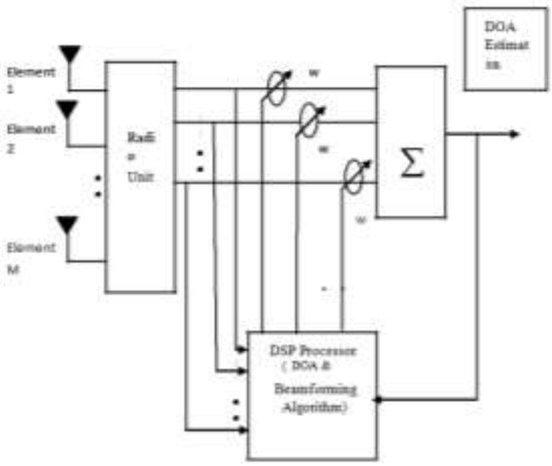

Fig. 2 Block Diagram of Smart antenna Propagator method for DOA estimation and beamforming

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RESULTS AND DISCUSSION

Two examples are considered for this method. For each case a six element ring array of radius 5 cm wavelength is used. The following parameters' are used for the system development in MATLAB,

Table 1. Performance of Simulation table Parameters

S. No.	**Parameters**	**Value**
1	No. antenna	7
2	radius	5 cm
3	Frequency	2.4 GHz
4	Receiver distance	10 M

The simulation results of optimize and without optimize is shown below

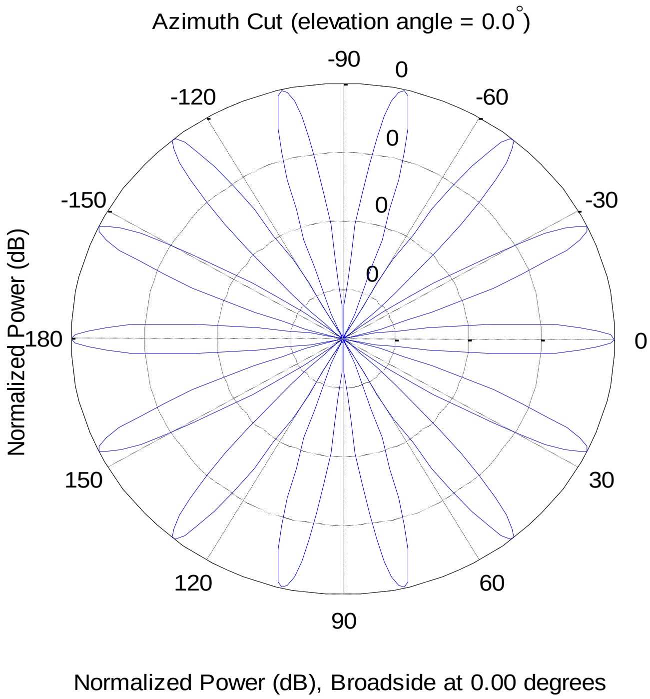

Fig:3Without optimization beam pattern

The simulation results of optimize and MFO based optimization is shown below MFO based optimization

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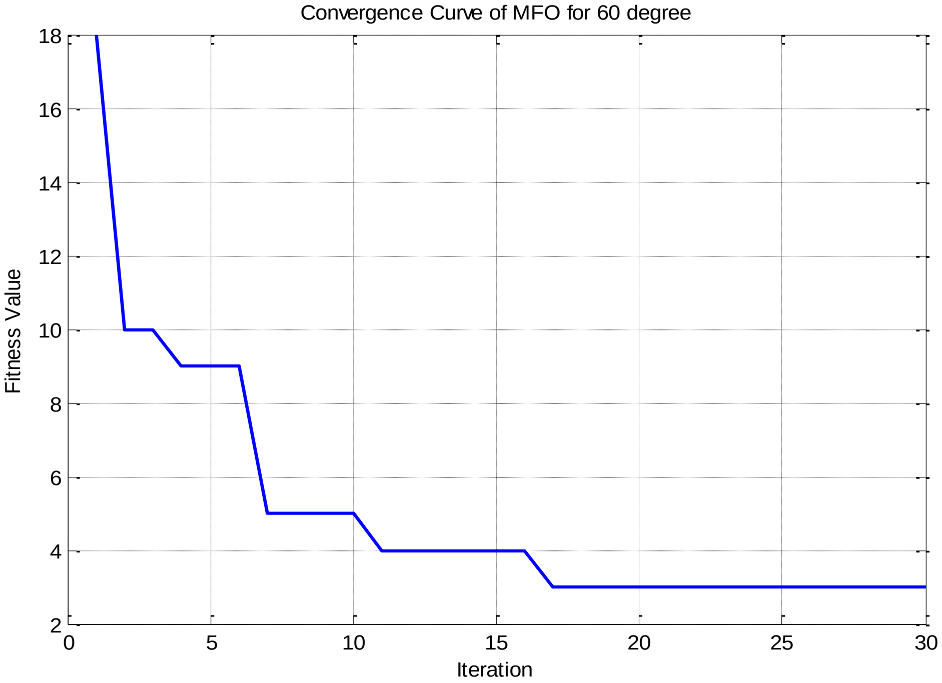

Fig: 4 Optimization based Fitness curve

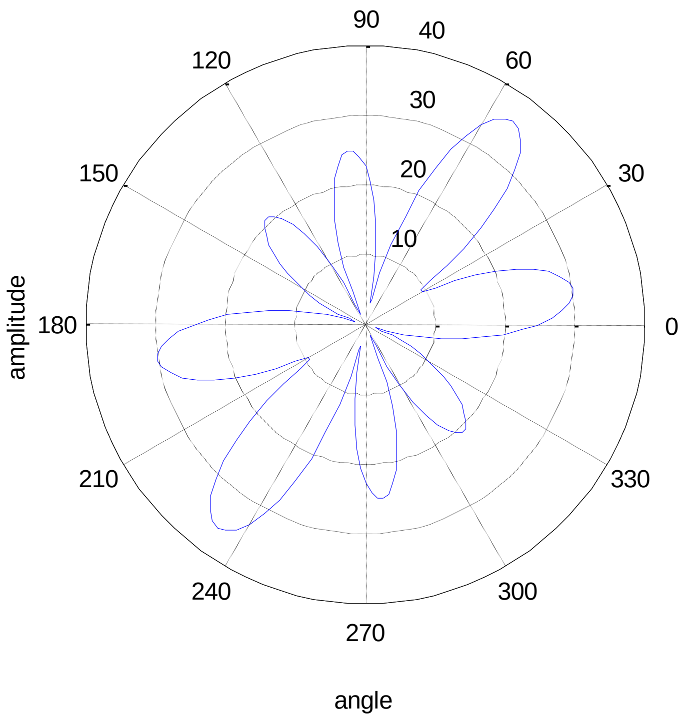

Fig: 5 Optimized Beam pattern at 60 degree

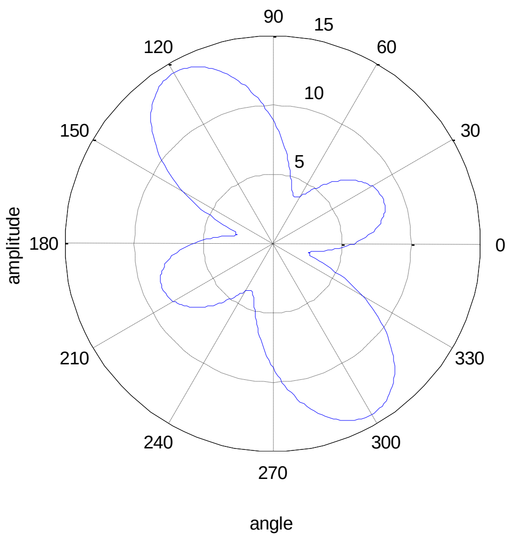

Fig: 6 Optimized Beam pattern at 120 degree

CONCLUSION

A circular antenna array of elements is used because with no real dimensions this is a basic antenna structure. Though with of the array in which the only degree of freedom was the inter-element spacing, the objective function was based on an optimization utilizing the ratio of quadratic forms. Use of Moth Flame Optimization algorithm to optimize the directivity proved very well for the specified scope of work and eight element circular isotropic arrays have been optimized using the algorithm providing better directivity. The directivity is also increase with no. of antenna elements but this method introduces complexity.

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Namdeo, A., & Chouhan, S. (2017). PERFORMANCE ANALYSIS OF THE MFO BASED BEAM STEERING FOR CIRCULAR ANTENNA ARRAY. *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY, 6*(6), 107-114. doi:10.5281/zenodo.805367