Global Journal of Advance Engineering Technologies and Sciences

IMPROVE THE PERFORMANCE OF LINEAR ARRAY BY REDUCING SIDE LOBE LEVEL AND BEAM STEERING BY GENETIC ALGORITHM

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ABSTRACT

This paper describes advanced methods for adaptive beam forming for linear antenna array to reduce the side lobe level (SLL) towards the main beam. for reduction of side lobe level and beam steering, we are introducing the genetic algorithm .genetic algorithm is a optimization method which work on the principle of survival of fittest and implemented using computer simulation .genetic algorithm can determine the various values of phase excitation for each antenna element to steer the main beam in specific location .this technique provide its effectiveness in improving the performance of the antenna array. This application is used in smart antenna for wireless communication, mobile communication.

Keywords: Adaptive beam forming, side lobe level, genetic algorithm phase antenna array, array factor

INTRODUCTION

There are various methods for solving the synthesis of linear array. It can be solved by analytical methods, numerical methods, adaptive method. We have introduced the genetic algorithm. Adaptive beam forming is a signal processing technique in which the electronically steerable antenna arrays are used to obtain maximum directivity towards signal of interest (SOI) and null formation towards signal of not interest (SNOI) i.e instead of a single antenna the antenna array can provide improved performance virtually in wireless communication. in many communication system , one is interest in point to point communication for that application directive beam of radiation pattern are required . To obtain the radiation pattern ,the characteristics of the antenna array can be controlled by the changing the space among array element and array excitation. But side lobe reduction in the radiation pattern should be performed to avoid degradation of total power efficiency and the interference suppression must be done to improve the Signal to Noise plus Interference ratio (SINR). Side lobe reduction and interference suppression can be obtained using the following techniques: 1) amplitude excitation 2) phase excitation 3) position excitation 4) complex weights (both amplitude and phase excitation).In this, complex weights technique is the most efficient technique because it has greater degrees of freedom for the solution space. On the other hand it is the most expensive to implement in practice.

Pattern synthesis is the process of choosing the various antenna parameters to obtain desired radiation characteristics, such as the specific position of the nulls], the desired sidelobe level and beam width of antenna pattern. In literature there are many works concerned with the synthesis of antenna array.

GENETIC ALGORITHM

Genetic Algorithms are global search algorithm based on the mechanism of natural selection and natural genetics Genetic Algorithms are typically implemented using computer simulations in which an optimization problem is specified. For this problem, members of a space of candidate solutions called individuals are represented using abstract representations called chromosomes. The GA consists of an iterative process that evolves a working set of individuals called a population toward an objective function, or fitness function. Traditionally, solutions are represented using fixed length strings, especially binary strings, but alternative encodings have been developed. The following parameters of GA decide the performance of optimization. Genetic algorithms have been used for difficult problems (such as NP-hard problems), for machine learning and also for evolving simple programs. They have been also used for some art, for evolving pictures and music. A few applications of GA are as follows:

The parameter of GA can be summarized by:
1.Crossover type and crossover rate.
2. Mutation type and mutation rate.
3. Population size.
4. Selection procedure.
5. Number of generations

These parameter is defined as:
• Crossover – exchange of genetic material (substrings) denoting rules, structural components, features of a machine learning, search, or optimization problem. for an optimization problem. It may be a single point cross over , two point cross over, cut and splice, uniform crossover or half uniform crossover.

• Mutation – the modification of chromosomes for single individuals.
•Population - the number of chromosomes considered in one generation.
• Selection – the application of the fitness criterion to choose which individuals from a population will go on to reproduce. Some general methods used are Roulette Wheel Selection and Tournament Selection.
• Reproduction – the propagation of individuals from one generation to the next.
• Number of generations – the maximum number of generations that the genetic algorithm can evolve into, before terminating.

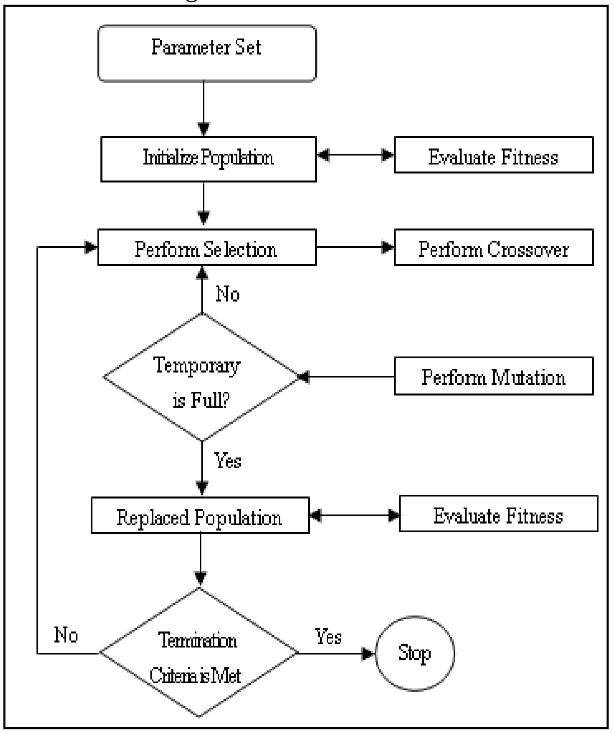

Fig. 1 flow chart of genetic algorithm

UNIFORM LINEAR ANTENNA ARRAY

linear antenna array, all the antenna elements are arranged in a single line with equal spacing between them. Due to far field Consideration, the incident wave is assumed to be a plane wave which causes a linear gradient time delay between the antenna elements that is proportional to the angle of incidence. This time delay will lead to progressive phase shift between the elements. it is shown in fig 2 that the antenna elements are arranged with uniformly spacing, in a straight line along the y-axis, and N is the total number of elements in the antenna array with the physical separation distance as d, and the wave number of the carrier signal is $k = 2\pi/\lambda$. When kd is equal to π (or $d = \lambda/2$) Arrays of antennas are used to direct radiated power towards a desired angular sector. The number, geometrical arrangement, and relative amplitudes and phases of the array elements depend on the angular pattern that must be achieved.

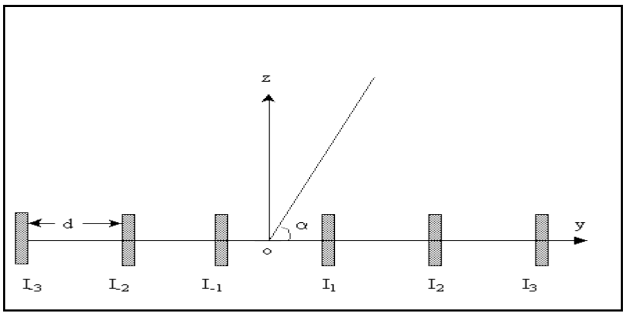

Fig.2 linear antenna array

Once an array has been designed to focus towards a particular direction, it becomes a simple matter to steer it towards some other direction by changing the relative phases of the array elements—a process called steering or scanning.

A linear antenna element, say along the z-direction, has an omni directional pattern with respect to the azimuthally angle φ. By replicating the antenna element along the x- or y-directions, the azimuthally symmetry is broken. By proper choice of the array feed coefficients an, any desired gain pattern g(φ) can be synthesized. If the antenna element is replicated along the z-direction, then the omni directionality with respect to φ is maintained. With enough array elements, any prescribed polar angle pattern g(θ) can be designed. The goal in antenna array geometry synthesis is to determine the physical layout of the array that produces the radiation pattern that is closest to the desired pattern. In this paper the design goal for a linear antenna array of isotropic elements covers suppression of SLL and restriction of the BWFN to its initial values as far as possible. This is done by designing the relative spacing between the elements, with a non-uniform excitation over the array aperture.

Array factor :

array factor is the function depends only the geometry of array and excitation of element. The phase shift between the elements experienced by the plane wave is $kd\cos\theta$. Weights can be applied to the individual antenna signals before the array factor (AF) is formed to control the direction of the main beam as shown in Fig 3. This corresponds to a multiple-input-single-output (MISO) system. The total AF is just the sum of the individual signals, given by

$$AF = \sum_{n=1}^{N} En = \sum_{n=1}^{N} e^{jkn}$$

we have only interest on magnitude of the array factor in any direction. Only relative phase of the individual antenna signal are important for calculating array factor.

PROBLEM FORMULATION

An array of antenna consisting of N number of elements. It is assumed that the antenna elements are symmetric about the centre of the linear array. The far field array factor of this array with an even number of isotropic elements (2N) can be expressed in

$$AF(\theta) = 2\sum_{n=1}^{N} a_n \cos\frac{\pi}{\gamma} d_n \cos\theta$$

Where a_n is the amplitude of the nth element, θ is the angle from broadside and d_n is the distance between position of the nth element and the array centre. The main objective of this work is to find an appropriate set of required element amplitude an that achieves interference suppression with maximum sidelobe level reduction. To find a set of values which produces the array pattern, the algorithm is used to minimize the following cost function where $F_0(\theta)$ is the pattern obtained using our algorithm $F_d(\theta)$ is the pattern desired.

$$cf = \sum_{\theta=-90}^{90} w(\theta)(F_0(\theta) - F_d(\theta))$$

Here it is taken to be the Chebyschev pattern with SLL of -14dB and $W(\theta)$ is the weight vector to control the side lobe level in the cost function. The value of cost function is to be selected based on experience and knowledge.

RESULTS AND DISCUSSION

The approach presented earlier has been applied to different linear arrays. Particularly,5element and 10 and 15 element arrays have been chosen as the work it has been concluded to the fact that the dolph chebybscheff Works better with large arrays. At start up the two arrays have been synthesized for radiation pattern matching purpose only. Then the side lobe level constraint has been included. Three direction of the main beam have been chosen for each array: 140°, 160° 90° and Satisfactory results were achieved. The resulting patterns of the 5, 10, 15 element, array along with the samples of the desired pattern having the main beams directed towards 90° in bidirectional pattern respectively. And relative side lobes are reduced. the main beam has been matched at exactly the desired direction. The numbers of radiating element are reduced at minimum level.However, the side lobe level exceeded the beforehand set value and hence needs to be reduced to meet the requirements of modern communication systems.

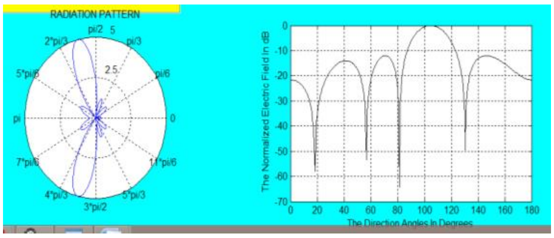

Figure 3 Radiation pattern with side lobe level of -9.6dB

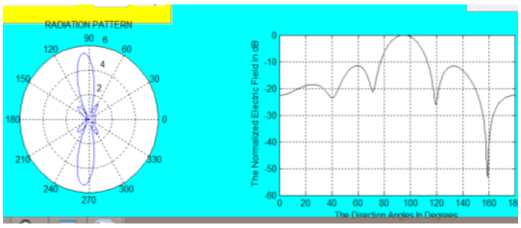

Figure 4 Radiation pattern with side lobe level of -11.9 dB

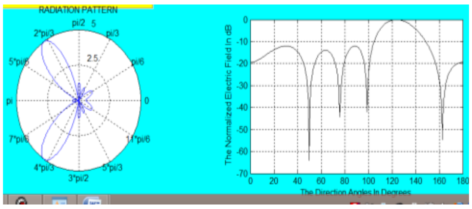

Figure 5 Radiation pattern with side lobe level of -12.0416

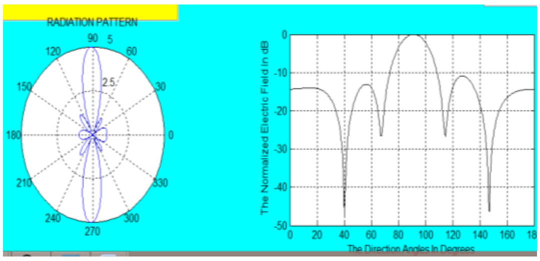

Figure 6 Radiation pattern with side lobe level of -13.13 dB

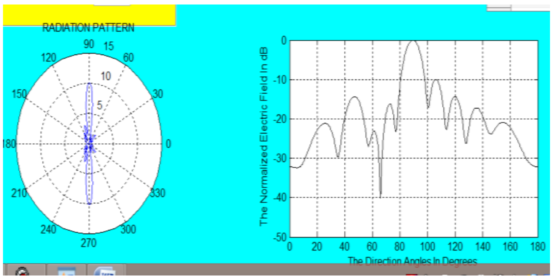

Figure 7 Radiation pattern with side lobe level of -19.8 dB

CONCLUSION

In this paper genetic algorithm is one of optimization toolbox of MATLAB which is used to obtain maximum reduction in side lobe level relative to main beam on both side of 0°and also steer te main beam at different angles. GA can be used for the synthesis problem of linear array. we have conclude that using the phase excitation the beam steer at various location and directive radiation pattern with minimum side lobe are obtain.

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