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Optimization of Antenna Array Using Genetic Algorithm

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Abstract—This technique for linear antenna array is used to optimize the sidelobe level and the null points. Here , for this Genetic Algorithm is being used . In this paper with the help of GA , optimization of three parameters spacing, excitation, and phase is being done. In this, it is performed on 16 element array. In case of optimization of distance we get the SLL reduction of -30dB.

Keywords— Genetic Optimization , Linear arrays , Excitation , Sidelobe level.

I. INTRODUCTION

Array elements are formed by arranging the elements in the desired geometrical format. Here in this we take the elements to be omni directional. When we make the addition of the individual elements in vector field we get the desired total field. There are total of five parameters which are required to arrange the antenna pattern properly as : Geometrical configuration (Linear, rectangular, circular, spherical), distance between the elements (element spacing) , Excitation amplitude of the elements, Excitation phase of the elements, pattern of the elements.[1]. In this paper, array factor is optimized by adjusting excitation amplitude, phase and element spacings . These optimization results are repeated using GA technique to optimize both sidelobes level and nulls.[2]

GA is robust technique used for optimization for complex problems . This is achieved by Darwainian principle which is of reproduction .[3] In this algorithm , genes of parent individual are copied to the new population according to its strength . In this process there are mainly three steps: selection , crossover and mutation. In selection process GA chooses the highest fitness from the desired individuals. In crossover process, here genetic recombination occurs in which two new individuals form from two existing individuals.In mutation process , here new individual being created from parent individual by randomly mutating one or more characteristics in a randomly chosen method.[2]

The paper is organized as follows. The problem formulation is presented in Section 2. The results and discussions are given in Section 3 followed by conclusion in Section 4.

II. PROBLEM FORMULATION

Here in this the main motive is to reduce the SLLs as well as the null points. In the first case, here we optimize the element spacing while amplitude remains one and phase zero . In the second case, we optimize the amplitude in which phase taken as zero and values of element spacings taken from the previous result, In the third and last array factor , optimization of phase is done and the element spacings taken from previous results .These all methods are cyclically repeated number of times to achieve optimization.[4]

The array factor is given as follows:

$$AF(\theta)=2\sum_{n=1}^{N} I(n)\cos[kz(n)\cos(\theta)+\phi(n)] \quad [5]$$

Where

N=number of elements;

Z(n)=distance of the nth element from origin;

I(n)= amplitude excitation of the nth element;

Φ(n)= phase of the nth element.

K=2*pi/λ wave numbers

Here, then absolute value is being calculated and its square be taken . Then we get the desired results , which is optimized using GA. The different parameters which are optimized : amplitude, distance and phase respectively in a cyclic order. This is performed on the MATLAB toolbox.[5]

In this problem , total of 16 elements are being used for array. Here also , firstly the initial value of amplitude is one and the value of distance be taken as lamda/2 and the phase excitation be taken as zero. Here the population is taken as: [2]

Initial amplitude excitation I(n)=1 for n=1,2,3….15;

Initial distance Z(n)=n*λ/2 for n= 1,2,3……15;

Initial phase excitation ϕ(n)=0 for n=1,2,3……15.

III. RESULTS AND DISCUSSIONS

In this section , result are presented and discussed .The first experiment is the synthesis of array factor by optimizing the element spacing. The second experiment is the synthesis of array factor by adjusting the feed current amplitude. The third example is the synthesis of array factor for by adjusting the feed current phase.In these all optimization techniques sidelobes band is from [1 88] and [94 181] , two bands of sidelobes and null directions be at 81 and 99 .

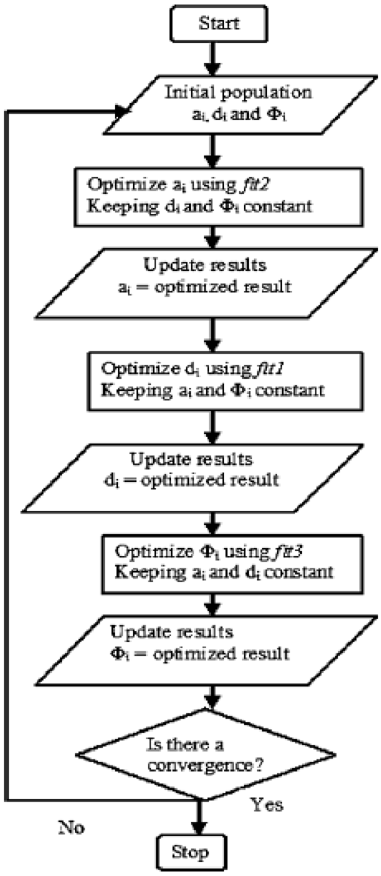

Fig. 1. Flowchart [2]

A. Optimization of array factor by adjustment of element spacing.

In this , sidelobes range is from [1 88] and [94 181] and the nulls direction is at 81 and 99.In this deep null of -40 dB occurs at 81 and 99 angle both. In this nulls of -75dB also occurs at 30 and 150 angle. Here two bands of sidelobes are there in which near lobes are at -15 dB from [78 to 82] and [91 to 93] and from [75 to 80] and [95 to 100] are at -25 dB and far lobes from [0 to 74] and [101 to 181] are below -30 dB.In this optimization of element spacing is done by keeping excitation amplitude one and excitation phase zero.

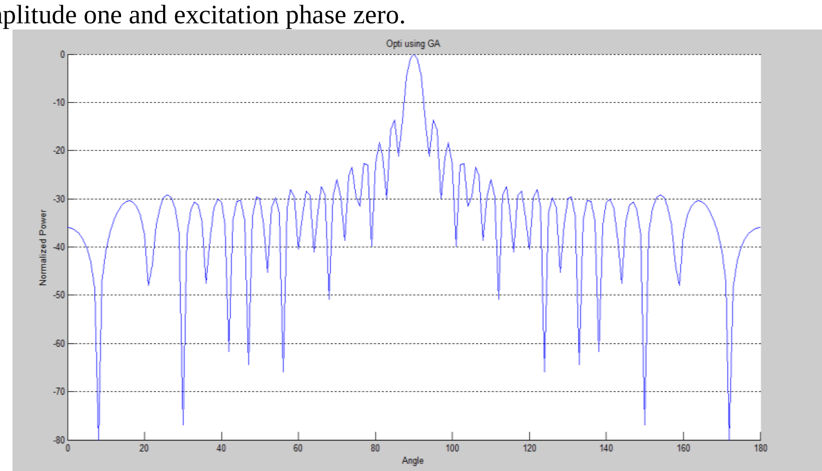

Fig. 2 Radiation Pattern of Antenna Array by Adjusting Element Spacing

B. Optimization of array factor by adjustment of feed current amplitude.

In this , sidelobes range is from [1 88] and [94 181] and the nulls direction is at 81 and 99. Here nulls are at -55dB at 81 and 99 angle both. Here sidelobes have band between [1 to 88] and [94 to 181]. Here sidelobes are below -30dB but nearlobes are at -15dB. In this excitation amplitude is varied and excitation phase be zero , and values of element spacing are taken from first result.

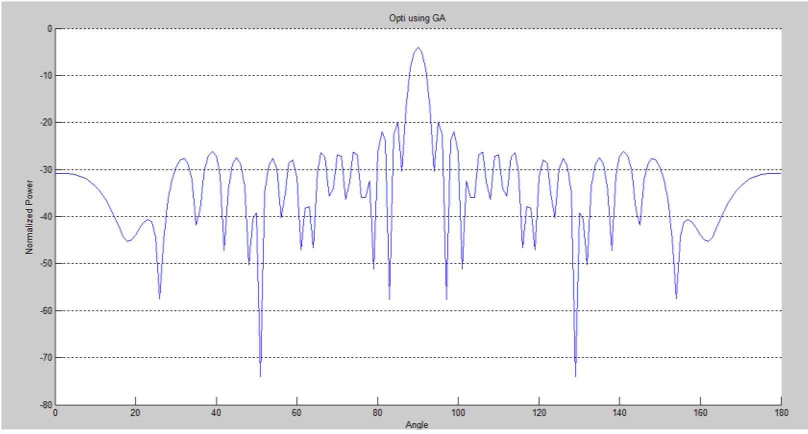

Fig.3 Radiation Pattern of Antenna Array by Adjusting Current Amplitude

C. Optimization of array factor by adjustment of feed current phase.

In this , sidelobes range is from [1 88] and [94 181] and the nulls direction is at 81 and 99. Here deep null of -80dB at 22 angle . Here sidelobes have band between [1 to 88] and [94 to 181]. Here sidelobes are below -15dB. In this excitation phase is varied and values of excitation amplitude and element spacing be from previous results.

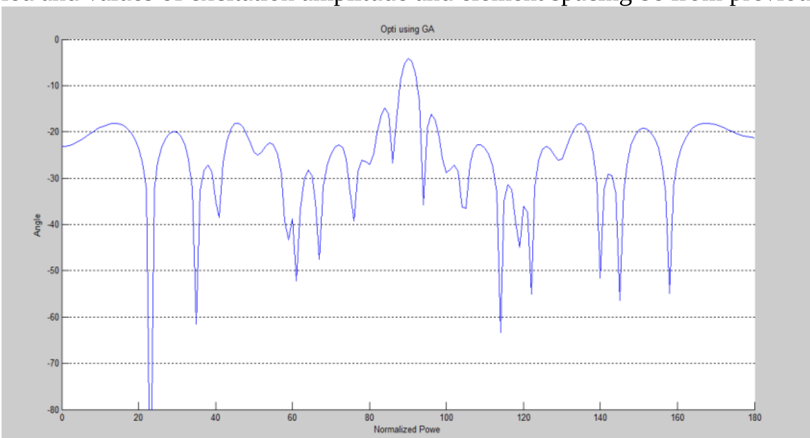

Fig.4 Radiation Pattern of Antenna Array by Adjusting Current Phase

Table 1 Results obtained after 10 cycles

Sr. No.	Distance	Amplitude	Phase
I.	0.47	0.75	4.08
II.	1.45	0.76	4.41
III.	2.43	0.61	6.04
IV.	3.42	0.61	4.11
V.	4.41	0.69	4.84
VI.	5.41	0.61	3.64
VII.	6.40	0.47	5.43
VIII.	7.37	0.60	3.72
IX.	8.35	0.75	3.16
X.	9.34	0.54	3.09
XI.	10.34	0.75	4.47
XII.	11.34	0.43	5.20
XIII.	12.34	0.62	4.57
XIV.	*13.36*	*0.47*	*3.61*
XV.	*14.42*	*0.59*	*4.50*
XVI.	*15.55*	*0.75*	*4.22*

IV. CONCLUSION

Here we conclude that GA utilizes the objective fuction to optimize the all three parameters namely excitation amplitude, excitation phase and element spacing . In this , objective function is repeated in GA , in the cyclic manner until it achieve the both sidelobe levels and nulls. Here , in this amplitude optimization , nulls are better at angles 81 and 99 respectively.So , we can say amplitude optimization is best in case of nulls . But in the case of sidelobes , element spacing optimization is better than that of other two . So we can say sidelobe level is best in case of element spacing . In future, here two simultaneously parameters can also be considered.

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