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Review Paper on Optimization of reduction in Side Lobe Level using Genetic Algorithm

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Abstract: The antenna is the basic part or the back bone of the wireless communication. It is mainly used as device to transmit and receive signal. To get better facility from this device it is necessary to modify or synthesize the geometric configuration or the other parameter of the device. This modification of the parameter of the antenna for getting our desired requirement is known as antenna synthesis. The Radiation Pattern of an antenna array depends strongly on the weighting method and the geometry of the array. Selection of the weights has received extensive attention, primarily because the radiation pattern is a linear function of the weights. Side lobe level is an important metric used in antenna arrays and depends on the Weights and positions in the array. A method of determining optimal side lobe minimizing Weights is derived that holds for any linear array geometry. The Genetic algorithm solver from the optimization toolbox of MATLAB is used to reduce side lobe level. Here I am writing a review paper on Optimization of Reduction in Side Lobe Level Using Genetic Algorithm on the basis of some published papers, articles, power point presentation.

Keywords: Side lobe level, Genetic Algorithm, Linear antenna array, Pattern synthesis, convergence, Array factor, Antenna synthesis.

Introduction

I am quite pleased today to find myself to have an Opportunity to write a review paper on Optimization of Reduction in Side Lobe Level Using Genetic Algorithm Here I am just discussing about different method used for Optimization of Reduction in Side Lobe Level. There is number of Technique used to reduce side lobe level to save power and make maximum radiation in desired direction, It is not possible for me to cover all methodologies used to reduce side lobe level, so that I am representing some of them methods used for reducing side lobe level. These methods are described in section 2 different methods used for reducing side lobe level using Genetic Algorithm.

Different methods used for reducing Side Lobe Level by Genetic Algorithm

In this section, some of the methods for optimization of Reduction in side lobe level by Genetic Algorithm are described:

A. Array Patterns Synthesizing Using Genetic Algorithm

After studied this paper I found that a planar array antenna with arbitrary geometry synthesis technique based on genetic algorithm used this approach avoids coding/decoding and directly works with complex numbers to simplify computing programming and to speed up computation. This approach uses two crossover operators that can overcome premature convergence and the dependence of convergence on initial population. Simulation results show that this method is capable of synthesizing arrays whose elements are located on irregular grids, and generates quite complex shapes and can realize good side lobe suppression at the same time. This approach is capable of synthesizing quite complex shapes of 3D patterns for main lobe and can realize good side lobe suppression at the same time. The method has been proved to be useful for the synthesis of large array antennas whose elements are located on irregular grids [1].

B. A Modified Sierpinski Pattern Thinned Planar Array of Rectangular Micro strip Antenna with Reduced SLL

In this Paper, B. Anirban Karmakar et. Al, proposed a novel technique to achieve reduced side lobe level by sequential modification of Sierpinski carpet patterned array. A 9×9 planar array is reduced to a Sierpinski carpet shaped array and after final modification it exhibits a peak SLL of -21dB and about 40% reduction in the number of elements. In this work, authors have achieved a SLL of -21 dB by sequentially modifying a Sierpinski carpet patterned planar Micro strip array. So incorporating fractal pattern in antenna array thinning enhanced the step towards achieving low SLL and optimum reduction in the number of elements. An improvement in peak SLL of about -21dB with 40% reduction was achieved in this work [2].

C. Design and Optimization of Antenna Arrays for 60 GHz Hybrid Smart Antenna Systems with Consideration of Inter Element Electromagnetic Interactions

After studied this paper I found that the use of directive elements, element tilting, and beam forming with a sub array are proposed in order to reduce computational complexity and cost of smart antenna array systems. This approach is termed as the Hybrid Smart Antenna System as it combines advantages from both the adaptive and switched beam approaches. A genetic algorithm based array geometry optimization procedure that determines the element tilt angles to uniformly cover a given angular range by adaptive beam steering for 60 GHz wireless applications is described [3].

D. Design of Scannable Non-uniform Planar Array Structure for Maximum Side-Lobe Reduction

In this article a novel design scheme is presented for optimal non-uniform planar array geometry in view of maximum side-lobe reduction. This was implemented by a thinned array using a genetic algorithm. Researchers have shown that the proposed method can maintain a low side-lobe level without pattern distortion during beam steering. In this research letter, a pattern synthesis method to obtain the optimal NUSPA geometry with a low SLL is presented. The results show that the optimized NUSPA using the proper boundary and initial conditions can sufficiently reduce the MSLL without pattern distortion, although the main beam direction is steered [4].

E. Amplitude only pattern synthesis of arrays using genetic algorithms

In this Paper Mr. V. RAJYA LAKSHMI, and G. S. N RAJU described that Array pattern synthesis is one of the most important problems in communication and radar applications. The synthesis is usually carried out by controlling amplitude and phase levels (or) element spacing functions of the array. Although, uniform linear arrays cost effective in terms of sources it is not preferred due to high presence of high first side lobe levels i.e. – 13.5dB. For point to the point communications, and high angular resolutions radars, it is essential to generate low side lobe narrow beams. In view of these facts, a linear array is considered in the present work and it is optimally designed using genetic algorithm. The desired amplitude levels are evaluated using the algorithm. The computed amplitude distribution, the realized radiation patterns over specified scan angles are presented [5].

F. Design and Analysis of Phased Antenna Array with Low Side lobe By Fast Algorithm

After studied this paper, I found that high performance phased antenna array is designed. Compared with the traditional ones, this antenna array has a lower side lobe characteristic of down to −16 dB. At different scanning angles, the comparison between calculated and measured results of S-parameters and E- and H-plane antenna patterns is made and a very good agreement is found. Moreover, the pre-corrected fast Fourier transform method is employed to accelerate the entire computational process to reduce significantly both the memory requirement and computational time, but to increase the design accuracy and optimization efficiency [6].

G. Side Lobe Reduction of a Concentric Circular Antenna Array using Genetic Algorithm

After studied this paper I found that here a concentric circular antenna array (CCAA) consists of elements positioned on the periphery of imaginary circles on a plane having a common centre and different radii are proposed. The simplest way to feed the elements of such an array is to use uniform excitation. However, with a non-uniform excitation profile, considerable reduction of the side lobe level (SLL) may be achieved at the cost of the added complexity. The difference of SLLs (with respect to the uniform excitation case) becomes even more prominent when the beam width of the antenna needs to be kept fixed. In this paper, we formulate the task of designing a non-uniformly excited CCAA as a constrained optimization problem and use genetic algorithm (GA) to solve the same. The goal is to determine an optimum set of weights for antenna elements which provides a radiation pattern with maximum SLL reduction with the constraint of a fixed beam width [7].

H. Side lobe Reduction by Non uniform Element Spacing

In this paper, Mr. Roger F. Harrington described a perturbational procedure for reducing the side lobe level of discrete linear arrays with uniform amplitude excitation by using non uniform element spacing is presented. The calculation of the required element spacing's is quite simple. The method reduce the side lobe level to about 2/N times the field intensity of the main lobe, where N is the total number of elements, without increasing the beam width of the main lobe. Several examples are given [8].

I. An Introduction to Genetic Algorithms for Electromagnetic

After studied this paper I found that Genetic algorithms are "global" numerical-optimization methods, patterned after the natural processes of genetic recombination and evolution. The algorithms encode each parameter into binary sequences, called a gene, and a set of genes is a chromosome. These chromosomes undergo natural selection, mating, and mutation, to arrive at the final optimal solution. After providing a detailed explanation of how a genetic algorithm works, and a listing of a MiZAB code, the article presents three examples. These examples demonstrate how to optimize antenna patterns and backscattering radar-cross-section patterns. Finally, additional details about algorithm design are given [9].

J. Synthesis of Linear Antenna Array using Genetic Algorithm to Maximize Side lobe Level Reduction

After studied this paper, I found that authors have used the Genetic algorithm optimization method for the synthesis of antenna array radiation pattern in adaptive beam forming. The synthesis problem in this paper discussed is to finding the weights of the antenna array elements that are optimum to provide the radiation pattern with maximum reduction in the side lobe level. This technique proved its effectiveness in improving the performance of the antenna array [10].

Conclusion

After reading some article, books and research papers, we conclude that till Side lobe level are reduced up to -15db. The maximum radiation in desired direction depend on reduction of side lobe level as side lobe reduce so as Directivity can also improve.

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