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Performance Analysis of Different Radiation Pattern using Genetic Algorithm

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ABSTRACT

In most applications of antenna arrays, side lobe levels (SLLs) are commonly unwanted. Especially, the first side lobe level which determines maximum SLL is the main source of electromagnetic interference (EMI), and hence, it should be lowered. In this thesis proposed a very simple and powerful method for the synthesis of linear array antenna. This method reduced the desired level of side lobe level (SLL) as well as to steer the main beam at different-different angle. In this paper we draw the radiation pattern for N = 24 elements with main beam are shifted by 30° and the simulation result analysis by Matlab R2013a tool.

KEYWORDS: *Side Lobe Level (SLL), Electromagnetic Interference (EMI), Genetic Algorithm (GA), Linear Array Antenna, Radiation Pattern*

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1. INTRODUCTION

Genetic algorithms belong to a stochastic class of evolutionary techniques, whose robustness and global search of the solutions space have made them extremely popular among researchers. They have been successfully applied to electromagnetic optimization, including antenna design as well as smart antennas design. Communication, radar and remote sensing systems employ thousands of different types of antennas, and there is an increasing need for them to be high-performance and customized. Traditional methods of designing and optimizing antennas by hand using simulation or analysis are time- and labor-intensive, and limit complexity.

2. LITERATURE SURVEY

[1] Geng Sun et al. (2018), **An Antenna Array Sidelobe Level Reduction Approach through Invasive Weed Optimization**, Hindawi, International Journal of Antennas and Propagation, Vol. 2018, The problems of synthesizing the beam patterns of the linear antenna array (LAA) and the circular antenna array (CAA) are addressed.

[2] Maryam Hesari et al. (2017), **Introducing Deeper Nulls and Reduction of Side-Lobe Level in Linear and Non-Uniform Planar Antenna Arrays Using Gravitational Search Algorithm,** Progress in Electromagnetics Research B, Vol. 73, in this paper, a recently developed metaheuristic algorithm, known as the Gravitational Search Algorithm (GSA), is employed for the pattern synthesis of linear and nonuniform planar antenna arrays with desired pattern nulls in the interfering directions and minimum side lobe level (SLL) by position-only optimization.

[3] Saeed Ur Rahman et al. (2017), **Analysis of Linear Antenna Array for minimum Side Lobe Level, Half Power Beamwidth, and Nulls control using PSO**, Journal of Microwaves, Optoelectronics and Electromagnetic Applications, Vol. 16 (2), This paper presents the optimization performance of non-uniform linear antenna array with optimized inter-element spacing and excitation amplitude using Particle Swarm Optimization (PSO).

[4] V. S. Gangwar et al. (2015), **Side Lobe Level Suppression in Randomly Spaced Linear Array Using Genetic Algorithm,** 2015 IEEE International Microwave and RF Conference, this paper presents synthesis of randomly spaced linear array (RSLA) with reduced side lobe level (SLL).

3. Genetic Algorithms (GA)

The basic principles of genetic algorithms (GAs) and their applications in computer systems were presented by Holland and de Jong in 1975 and described in detail by Goldberg. The GA starts forming, usually by random manner, an initial population of chromosomes (individuals). The performance of each individual is evaluated by the objective function or the fitness function, which determines the goal in each optimization problem. A high value on the objective function implies a good chromosome.

A. Smart Antenna System (SAS)

Omni-directional or sectored antennas used in current wireless communication systems, can be considered as an inefficient use of power as most of it has been radiated in other directions than toward the user. Signals that miss the intended user will cause interference to other users in the same or adjoining cells [1]. In the table 1 shown the Relationships between Genetic Algorithm and Antenna Parameters.

Table 1: Relationships between Genetic Algorithm and Antenna Parameters

GA parameter	Antenna array parameter
Gene	Bit String (I_i, β_i)
Chromosome	One Element of Array
Individual	One Array
Population	Several Arrays After encoding

B. Side-lobes and smart antenna systems

No antenna is able to radiate all the energy in one preferred direction. Some is inevitably radiated in other directions. The peaks are referred to as side-lobes, commonly specified in dB down from the main lobe, in figure 1 shows sidelobe and main lobe.

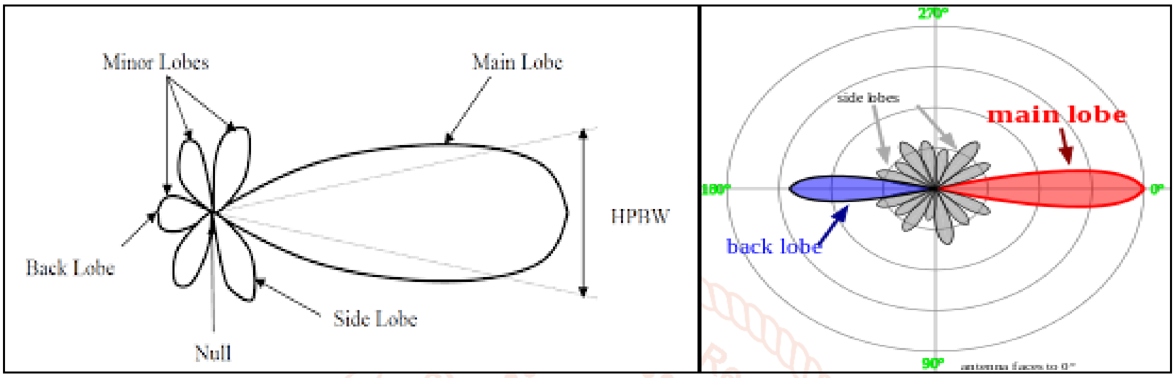

Fig. 1: Side-lobes, Main-lobe and Back-lobe.

The smart antenna systems for cellular base stations can be divided into three main categories, which are illustrated in Figure2.

- Switched Beam Systems.
- Phased Arrays and
- Adaptive Systems.

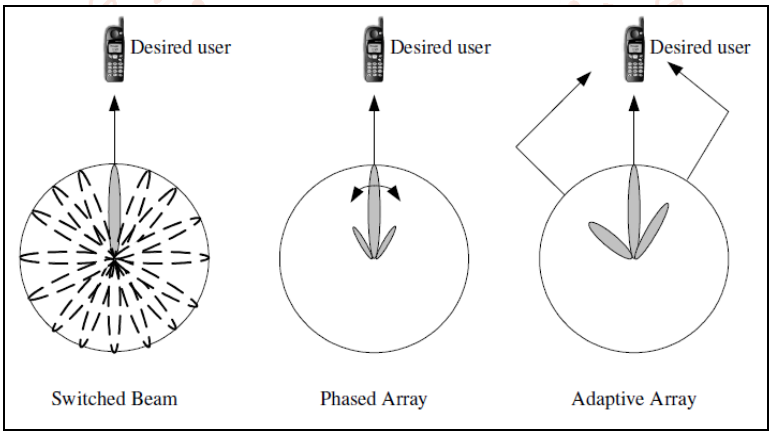

Fig. 2: (a) Switched Beam Systems, (b) Phased Arrays and (c) Adaptive Systems.

4. Simulation results for Radiation pattern when main beam is shifted by 30°

To evaluate the results of GA more objectively, at the same time, the pattern array antennas can be designed based on Chebyshev methods with the same conditions we have observed that from the classical array antennas theories, the lowest side lobe level can be get using Chebyshev method on condition that it is given certain side lobe bandwidth. But It must satisfy the condition of distance of array elements d $\geq$2.When d $\leq$2. Chebyshev method is not best, while GA can still work effectively.

Various results for different number of element as shown below in figure 3 to 8 with Radiation pattern when main beam is shifted by 30° and the simulation parameters shown in table 2.

Table 5.1 Simulation Parameters

S. No.	Parameter	Description
1.	Antenna array	Linear antenna array
2.	Optimization method	Genetic Algorithm
3.	Analysis	Reduction of SLL for given main beam direction
4.	Frequency	3GHz
5.	Element spacing	$\lambda/2$

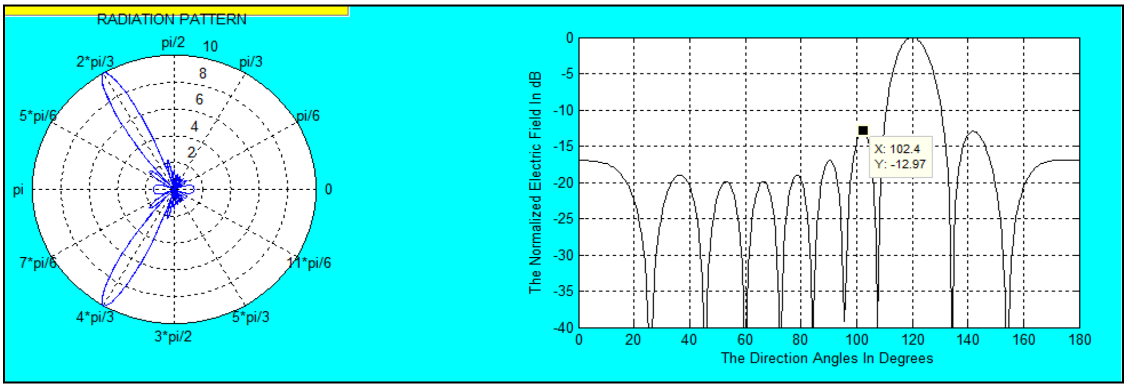

Fig. 3: Radiation Pattern for N = 10 element with main beam is shifted by 30°.

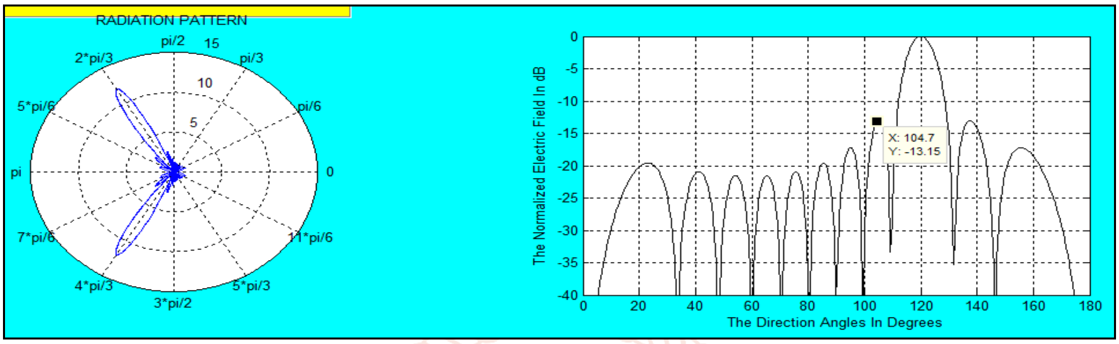

Fig. 4: Radiation Pattern for N = 12 element with main beam is shifted by 30°.

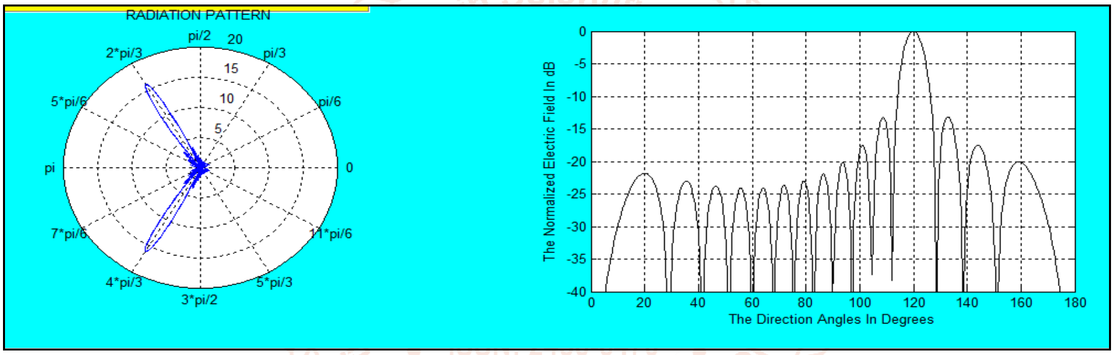

Fig. 5: Radiation Pattern for N = 16 element with main beam is shifted by 30°.

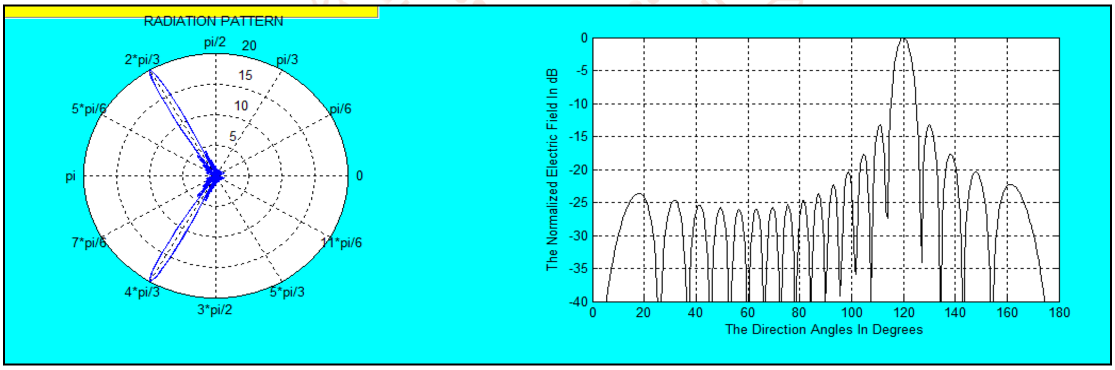

Fig. 6: Radiation Pattern for N = 20 element with main beam is shifted by 30°.

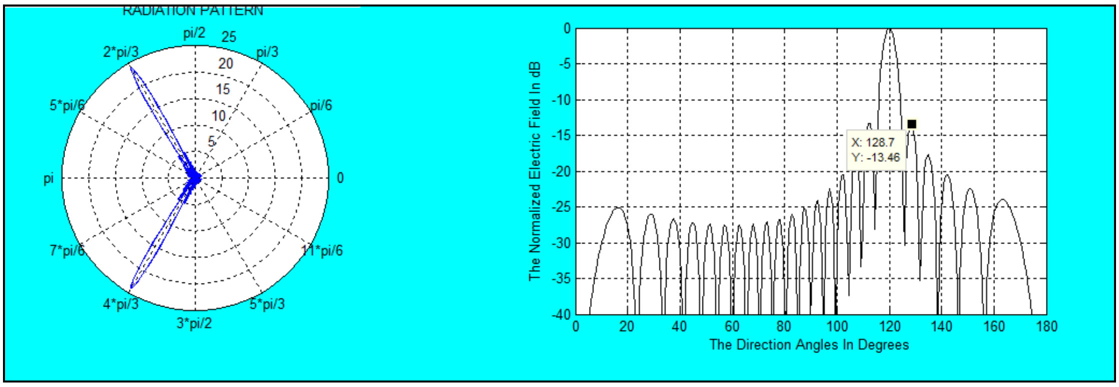

Fig. 7: Radiation Pattern for N = 24 element with main beam is shifted by 30°.

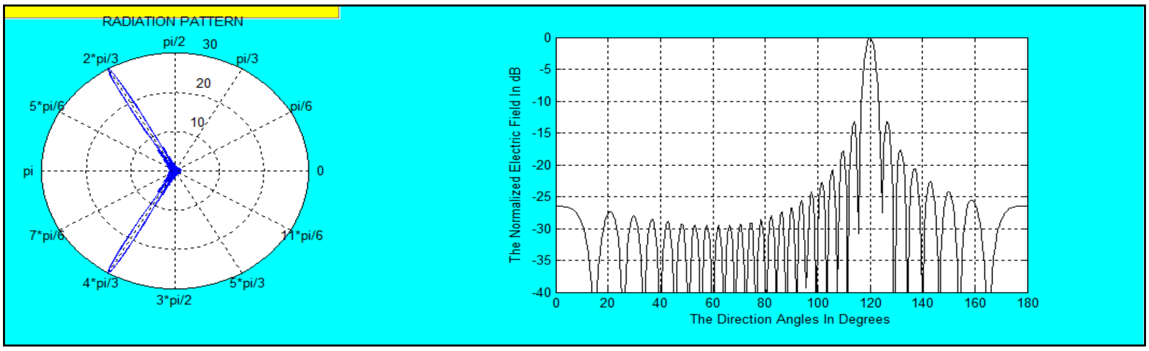

Fig. 8 Radiation Pattern for N = 30 element with main beam is shifted by 30°.

Table 3: Comparison of simulation results of different numbers of element with main beam is shifted by 30°.

S. No	No of Elements	Side lobe level	Directivity
1	10	-12.9701	15.6234
2	12	-13.1571	16.546
3	16	-13.258	17.8193
4	20	-13.302	18.8037
5	24	-13.4625	19.6059
6	30	-13.5801	20.5627

5. Conclusion:

Today, the significance of the wireless communication is known all over the world. In order to achieve the better communication, many techniques and methods have been introduced. Among these techniques, smart adaptive antennas are trending topic in the research domain.

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