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# Performance analysis of smart antenna array using genetric algorithm

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***Abstract*— the 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 times with manual approach they becomes complicated and time consuming. Though with continuous research has suggested many ways to improve optimization complexity, one of them is use of Genetic Algorithm (GA). The optimized array can be then verified using a machine simulator. Sometimes, software coded simulator also works. The research work intends to optimization of smart antenna performance using technique of Genetic Algorithm.**

**Keywords: Smart antenna, , Genetic algorithm, Phase angle, etc**

## I. INTRODUCTION

Recent updates in wireless communication were not possible without application of smart antennas. Use of smart antennas is one of the vital characteristic that has led to third and fourth generation standard developments. However, smart antenna theory is always driven by the Antenna array and so do the wireless communication. With antenna pattern synthesis there comes speed and robustness to the existing system thereby improvising transmission parameters [3]. Along with this radio wave propagation is a matter of research that accounts to faster and reliable transmission, since wireless is generated from the roots of radio communication. Radio communication was first came into existence in December, 1901 when Guglielmo Marconi successfully received the first transatlantic radio message [1].The message under radio communication was letter 'S' which is considered as the most significant approach in developments of radio communication.

A. ANTENNA PARAMETERS **:** A radio antenna is actually the structure associated with the transition region between a guided wave and free-space wave, or vice versa; as for transmission and reception. Thereby convert electrons to photons or vice versa.

B. WAVELENGTH**:** wavelength is the distance the first wave travels before the next one starts its journey away from the transmitting antenna. basically, this is the length of one rf wave. it can be computed by either of the following formulas, depending on the units required:

$$\lambda(\text{in m}) = 300/f(\text{in MHz}) \text{ or } \lambda(\text{in ft}) = 984/f(\text{in MHz})$$

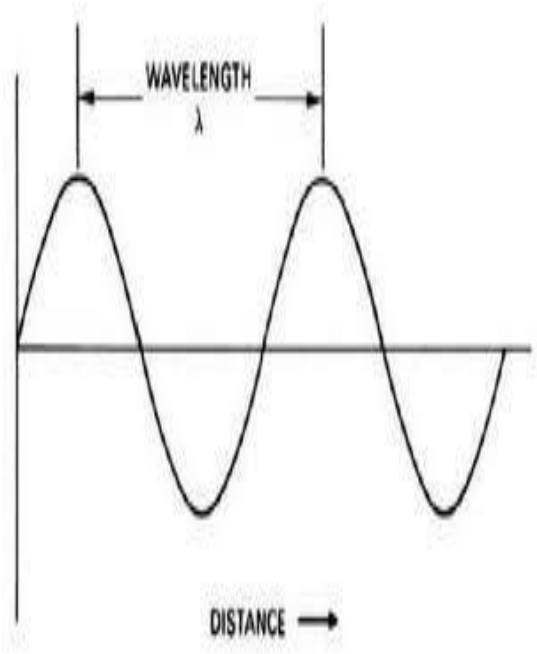


Figure 1 : Signal Wavelength

C. RECIPROCITY**:** Reciprocity property states that an antenna's electrical characteristics are the same no matter how is it used i.e. either as transmitter or receiver. It is one of the most useful property of antennas for parameters calculations. Reciprocity theorem, concluded that receive and transmit properties of an antenna are identical. So, the radiation pattern of transmit and receive antenna are always identical. For this reason, if one knows the transmitting radiation pattern, receiving radiation pattern can also be obtained.

D. POLARIZATION**:** It is the orientation of the electric field vector with respect to earth's surface for electromagnetic wave produced by the antenna. For most antennas, the orientation of the antenna conductor determines the polarization. Polarization may be in any direction say vertical, horizontal or elliptical. Thus a simple straight wire antenna will have one polarization in vertical mounting and different polarization while mounted horizontally.

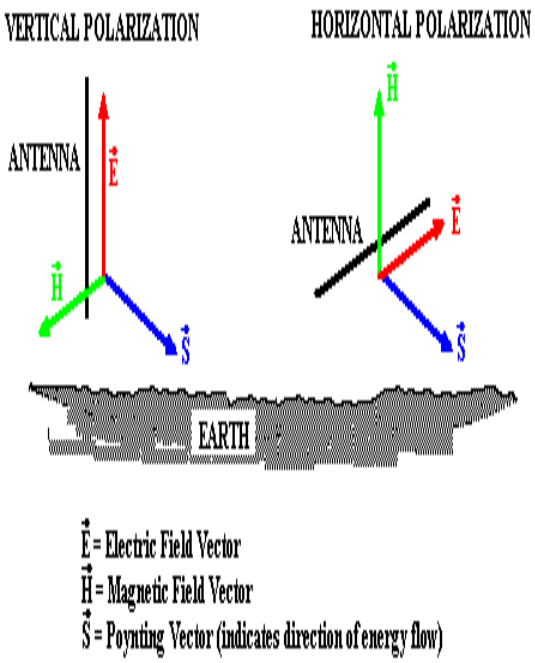


Figure 2 : An Antenna Reciprocal System

Vertical and horizontal polarization are illustrated in above figure . If the radio wave's electric field vector points in some other direction, it is said to be circular , elliptical polarized depending upon direction.

E.SIDE LOBE LEVEL **:** Side lobe levels are measured in decibel unit (generally written as 'db'). This is defined as the maximum value of amplitude at major lobe to the maximum amplitude value at minor (side) lobe. In general condition, side lobe seems to be adjacent with major lobe and signifies the same characteristics as that of major lobe occupying hemisphere in major lobe. In general speaking, people use side lobes as a synonym of minor lobe but theoretically, there are number of sub-lobes generates while drawing the antenna performance pattern but the maximum value of minor lobe is always referred to as side lobe.

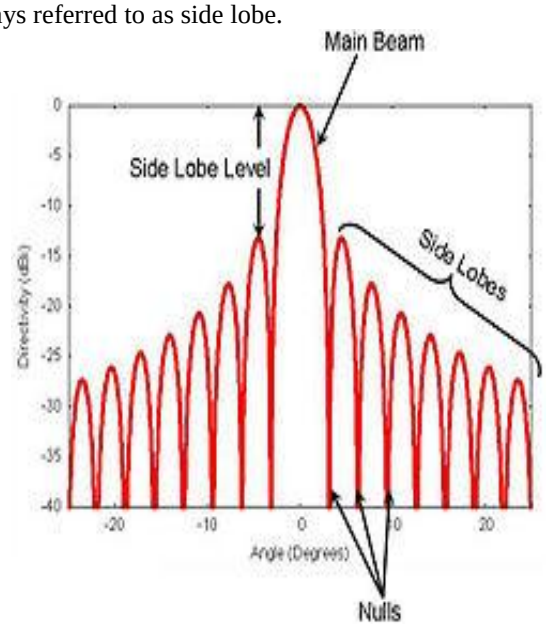


Figure 3:Illustration of Side lobes in antenna pattern

Reduction of side lobe is possible with tapering the edges at aperture distribution .However , this technique reduces directivity as well , so most antenna engineers do not prefer this method unless the need of side lobe optimization is important enough.

As the radiation pattern of antenna of an array contains several lobes of different intensity, depending on they are always termed up into two categories. The one with maximum radiation are major lobes while the other one with least amount of radiation in the pattern are side lobes.

F.FRONT-TO-BACK RATIO**:** It is the proportion of energy radiated in the principal direction of radiation to the energy radiated in the opposite direction. In general practice, a high value of front-to-back ratio is enviable as this reduces the probability of energy radiated in some other direction that will eventually causes side lobe generation.

To elaborate the antenna properties, a Cartesian coordinate system will be used with axis labeled as *x*, *y*, and *z* along with spherical coordinates θ. The polar angle taken here will be 0 to π and azimuth angle φfrom 0 to 2π.

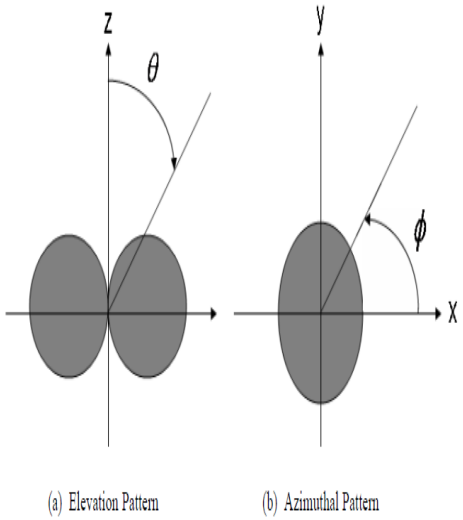


Figure 4:Pattern of Antenna

A physical antenna has a radiation pattern that varies with direction. By reciprocity, the radiation pattern is the same as the antenna's reception pattern [34], so the two can be discussed interchangeably. The radiation pattern is also a function of frequency .

This energy of signal is always measured at various angles placed at a constant distance from the antenna. The shape of the pattern varies with the type of antenna used. Antenna patterns are plotted with two different type of graph named polar co-ordinate and rectangular. However, in usual practice, polar co-ordinate graph dominates. In this type of graph, test points are located by projection along a rotating axis (radius in consideration) to an intersection with one of several concentric, equally-spaced circles. The below figure shows polar coordinate graph of a radiation pattern

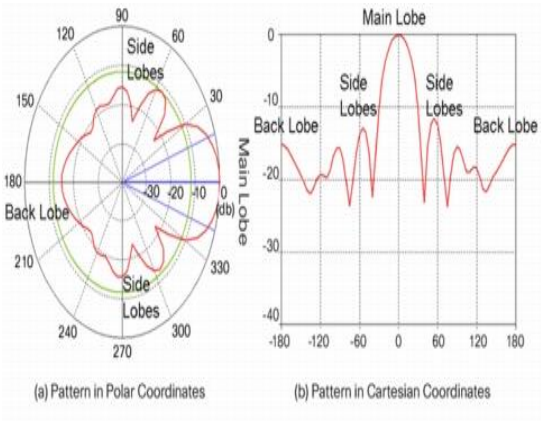


Figure 5: Antenna pattern in different coordinates

**Solution Domain**: Genetic Algorithm optimization method for the synthesis of antenna array radiation pattern thereby reducing the side lobe level of pattern. It can be achieved by finding the weights of the Smart antenna currents and phases that are finest enough to provide the radiation pattern with maximum reduction in the side lobe level in desired direction. This technique proved its effectiveness in improving the performance of the smart antenna.

## II.METHDOLOGY

A. ALGORITHM DESCRIPTION*: The Genetic Algorithm used for this optimization is an easy algorithm , especially for the realistic approach of coding and its hassle free approach. All program code will be write in MATLAB and simulated there only.Figure shows the flow chart of the Genetic Algorithm optimization process for ansmart antenna*

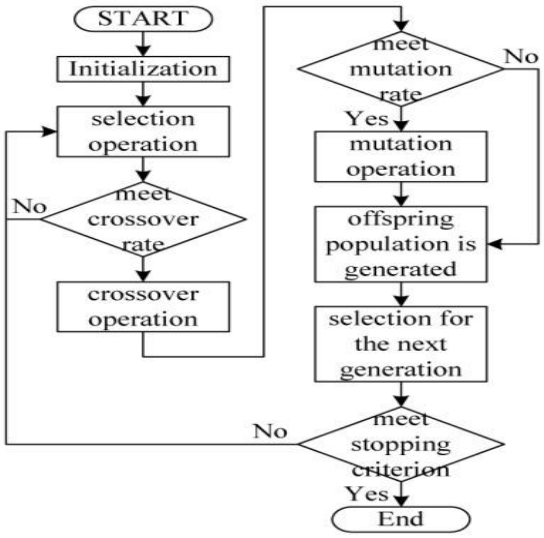


Figure 6: Genetic Algorithm for optimization of smart antenna

Within an isotropic array the only uneven is the inter element spacing and it is only variable parameter there. And here each gene of a chromosome shows the one inter-element space, therefore the number of genes (inter-element spaces) is the number of elements subtracted with one.

Although the Genetic Algorithm is a very useful tool in the optimizing an antenna, providing a better quality output. Therefore there are various aspects of this research that can be extended further:

The element linear array needs to be built and tested. As for an antenna , the antenna feeding of signals could be troublesome and it is also evident that without proper feed there will be much more degradation sin receiving parameters questioning the worth of antenna technology. So there is still a lot to explore about.

Evolutionary computing has vastly created its space in electromagnetic expanding at a faster rate. And in this thesis also , the Genetic Algorithms used proved to be ample and vigorous for purpose . The inventive objective of this research is to use Genetic Algorithm to optimize the directivity of a uniform linear antenna array. This has been accomplished with a directivity typically 0.0 dB .

## III RESULT

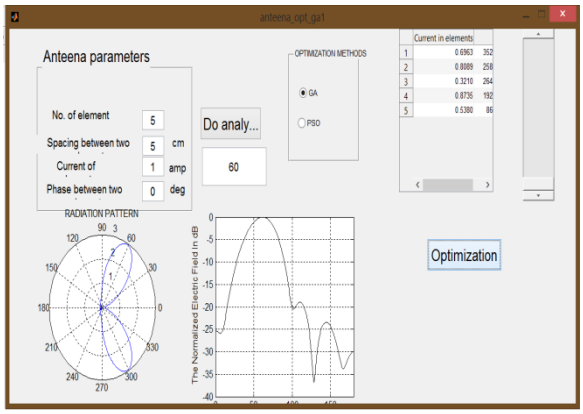


Figure 7 The performance of antenna parameter with genetic algorithm

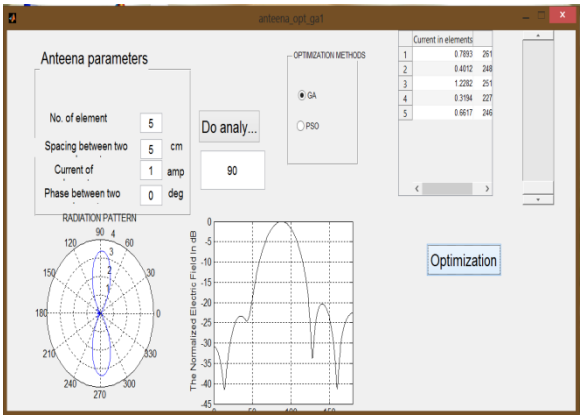


Figure 8. The performance of antenna parameter with genetic algorithm

**Table. 1- Optimize Side lobe level using GA**

| No of Elements | Desired Direction | Side Lobe Level in db in GA |
|---|---|---|
| 5 | 30 degree | -15 db |
| 5 | 45 degree | -20 db |
| 5 | 60 degree | -20 db |
| 5 | 90 degree | -20 db |
| 6 | 30 degree | -20 db |
| 6 | 60 degree | -20 db |
| 6 | 30 degree | -12 db |

## IV CONCLUSION

Antenna Performance can be improved using Genetic Algorithm (GA)

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