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Optimization Of Sectorial Antenna Using Genetic Algorithm

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Abstract: ***In this report Optimization of Sectorial Antenna is carried out using genetic algorithm. Optimization of sectorial antenna is a solution-oriented work. Antenna is an integral part of wireless communication. In general, a sectorial antenna is a directional antenna which has steady electrical qualities, for example, gain, impedance and front-to-back proportion over the extensive variety of frequencies contrasted with other antenna and it is for the most part utilized as a part of mobile communication. It is important to design such sort of antenna which is exceptionally productive regarding gain and possess little space in the system. To achieve the objective of little size and high gain, Genetic Algorithm (GA). optimization method was used. This Genetic Algorithm was implemented using a MATLAB. It was found that the Genetic Algorithm gave a similar arrangement in every trial. In any case, all in all the subsequent beam designs share a comparable side-lobe level. Also, the side-lobe level was additionally enhanced to around 17.5 dB with a fill rate of 76.5%, this means extra 9 dB side-lobe suppression enhancement.***

Keywords: Genetic Algorithm (GA), Sectorial Antenna (SA), Optimization, GPRS, GSM, MAT LAB

I. INTRODUCTION

An antenna is an integral component in any wireless communication system without which transmission and reception will be impossible. These days, data rate of many wireless applications are on the increase, while requiring small size of antenna to meet the miniaturization of things that the world requires now. It is necessary to design such kind of antenna which is very efficient in terms of gain and occupy small space in the system. The goal of small size and high gain can be obtained using some optimization techniques such as Genetic Algorithm (GA) For broadband wireless applications, sectorial antenna which is a directional microwave antenna. It has radiation pattern shaped in sector of 120 degrees. In general, a sectorial antenna is a directional antenna which possesses constant electrical characteristics such as gain, impedance and front-to-back ratio over the wide range of frequencies compared to other directional antennas. The largest use of these antennas is as antennas for cell phone base-station sites. They are also used for other types of mobile communications, for example in WIFI networks. They are used for limited-range distances of around 4 to 5 km.

Genetic Algorithm is based on the principle of best gene selection from a huge available population of genes. A portion of the worst population is rejected and the remaining population is arranged in a particular order. Two random selected best genes from the remaining population are allowed to mate and create a new population. After certain number of iterations, the available population, in general, is the best population. This principle of Genetic Algorithm is applied by different researchers on the antenna design (Mangoud, et al, 2003). Genes are the basic building blocks in any Genetic Algorithm technique. A gene is a binary encoding of a design parameters. Basically, chromosome is an array of genes. The chromosomes are evaluated by a function called cost function. The chromosomes are ranked from the most-fit to the least-fit and unacceptable chromosomes are discarded from the lower rank. Genes who survives become parents and by swapping some of their genetic material, new offspring is produced. The parents reproduce enough chromosomes to offset the discard

chromosomes. Thus, the total number of chromosomes remains constant in each iteration. Optimal sectoring can be achieved at different time of the day as traffic changes.

The main objective of this work is to get to wireless services has increased to an explosive optimal selection of the assigned sectors angles of rate. This growing demand for wireless the BTS such that the different sectors have communications services is constantly increasing properly balanced load all the time by using GA. the need for better coverage, improved capacity These sectors will be formed from different beams. and higher quality of service. These demands can Different beam angles can be obtained by be achieved by using smart antennas (Roy, 1998). Smart changing the number of antenna array elements or antennas (Liberti et al, 1999) are critical enabling technologies that the amplitude distribution they are fed. The first will provide high mobility in dense traffic areas. part of this work is to investigate the beam widths Smart antenna system (Lu et al, 2001) as one of the most produced using a linear array with varying number promising technologies in the cellular area, using of array elements and with different amplitude switched beam and adaptive antenna array with distributions

In wireless communication system, the mostly used antenna for microwave signal carrying is the sectorial antenna. To optimize is the need born out of the problems of network capacity and coverage. The optimized system is expected to increase system capacity by minimizing inter-cell interference and increase in coverage through higher antenna gain. The growing demand for wireless communication has led to the use of BTS antennas that are sectorized. Such that the different sectors have communications services is constantly increasing properly balanced load all the time by using GA. The need for better coverage, improved capacity, these sectors will be formed from different beams and higher quality of service.

II. RELATED LITERATURE

(Ho et al, 2006) considered the options of 3 and 4 sectors. The integral part of both analog and digital cellular decision of sectors assignment depends on the networks. Using the approach of smart antenna traffic capacity which can be represented by the with switched beam antenna system (Lu et al,1999), a measured power density received by the antennas intelligent sector synthesis of varying azimuth and of the BTS. The power measurement stage has not beam width can be established. Dynamic sectors been considered in our work but we will assume synthesis can be achieved by making the angles of two different power distributions for the assumed the sectors varying according to the traffic capacity 3 and 4 sectors with assigned hot spots. In which varies from time to time during the day. By second part of this work, an adaptive GA is doing so, traffic load balancing can be achieved. Introduced and used to solve the above problem. Another approach for load balancing is to use the This algorithm has a new adaptive mutation genetic algorithm (Jin, et al, 2006). The GA is a powerful mechanism which will maintain the best scheme in resource for electromagnetic optimization the solution and at the same time provides the problems (Yahya, 1999). Under GA control, the sector beam search space with new solution elements. The width can be varied with narrow beam widths in structure of the algorithm and a comparison heavy handoff area (hot spots) and wider beam between the obtained results and previous work widths in areas with low traffic density. Thus, has been made. Results have proved the effectiveness of the proposed algorithm. have been used to produce shaped beam patterns (Balanis,2001). Table 1 shows the simulated beam widths (BW) produced from a linear array element of isotopic type with resonance frequency of 2 GHz and inter-element spacing $\lambda/2$. Simulation results are obtained using antenna design software PCAAD 4.0 (Pozar, et al, 1999) for the most famous amplitude distributions.

Martaet al (2014) proposed an approach that predicts the propagation, models the earthbound receivers and advances the performance of single frequency systems (SFN) for digital video broadcasting (DVB) as far as the final coverage accomplished over any geological locale, upgrading the most populated regions, is proposed in this paper. The powerful scope change and along these lines, the self-interference lessening in the SFN is expert by advancing the inward static deferrals, part reception apparatus gain and both azimuth what's more, rise introduction for each transmitter inside the arrange utilizing the heuristic simulated annealing (SA) calculation. Destruction and rise sifting procedures have been considered and connected to diminish the minimize cost of the SA-based approach, including comes about that show the enhancements accomplished. Assist agent comes about for two SFN in various situations considering the impact on the last scope of enhancing any of the transmitter parameters beforehand delineated or a mix of some of them are announced and examined with a specific end goal to demonstrate both, the execution of the strategy and how expanding progressively the intricacy of the show for the transmitters prompts more reasonable and precise comes about.

III. METHODOLOGY

The sectorial antenna used by Global com; one the leading GSM network providers in the country Nigeria and Africa at large. A field trip was carried out to global com switching center in trans-Amadi in Port Harcourt Rivers. Data obtained from the Globacom switching center was applied in the MATLAB code to simulate the desired system using Genetic Algorithm whose steps are shown in the block diagram of figure1.

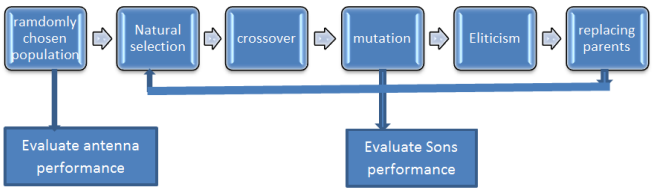

Figure 1: The Genetic Algorithm Optimization Block Diagram

IV. GENETIC ALGORITHM

A. RANDOMLY POPULATION

Usually, Genetic Algorithm begins with a population chosen at random. Chromosomes, and progresses toward better arrangements are made by applying the hereditary procedures happening in nature which are utilized to display hereditary administrators as appeared in condition 3.1. In these calculations a populace of answers for a given issue is kept up; this populace experiences development as regular determination. In every age, moderately great arrangements repeat to give posterity that supplant the generally awful arrangements which pass on. An assessment or wellness work assumes the part of condition to recognize great and awful arrangements. In this section a versatile GA is acquainted and utilized with advance the issue of the utilization area radio wire.

POPULATION INITIALIZATION

Population Initialization of Genetic Algorithm initializes the information individuals from the populace and produces the original of chromosomes with irregular esteems. It utilizes the unadulterated arbitrarily instatement procedure which is best in examine, in light of the fact that it illuminates the power of the calculation. Introduction is finished by haphazardly choosing things from the yield of the "possible combination "function to speak to what is known as the underlying populace P or POP (0) where P is known as the populace measure.

B. EVALUATION FUNCTION

The aim of the evaluation is to accomplish every division point with reasonable cluster mixes with least mistake. Three diverse mistake capacities have been used. The initial one marked as outright blunder (Ea(i)) which levels with the contrast between the required point and the created one acquired from the calculation:

Ea (I) = R (j) - An (I) 1

Where:

R (j): Required edge of the area j (the yield of sectoring capacity)

An (I): Individual I (at first the yield of conceivable mix work)

Amid trials, the Genetic Algorithm depended on the above mistake work. It has been discovered that some mistake esteems were substantial; which makes the normal wellness focalizes to an imperfect arrangement quick. So the second proposed blunder work was marked as outright standardized mistake (En(i)) which measures up to

$(E_a (I)) \div R (j)$: R (j) - An (I) (2)

E (I) = n R (j) (3)

The arrangement was enhanced and turned out to be nearer to the ideal. The third blunder work was proposed as the squared supreme standardized mistake:

The wellness work is conversely corresponding to the blunder work. In this way, the wellness work

F (I) is mathematically expressed as:

F (I) = 1/(1+ E (I)) 4

Where:

E (I) is the chosen mistake work. The generation administrator strategy is the "one-sided roulette wheel"

C. CROSSOVER OPERATOR

The hybrid administrator is the component that gives the GA work that proportionate to the generation of half breeds by hereditary qualities hybrid in normal framework. The most straightforward hybrid administrator takes bits from each parent and consolidates them to make kid strings. The calculation handles one kind of hybrid method, one point hybrid. Since our concern requires adjusting of accessible esteems, we haven't utilized other hybrid methods, for example, (two-point hybrid). In one point hybrid an irregular point is chosen which isolates each parent vector into two gatherings of qualities. At that point every youngster acquires one qualities amass from each parent progressively. The hybrid likelihood ρc is characterized as the likelihood or the rate of traverse along the populace. This implies not all the chose guardians are subjected to hybrid process, yet agreeing tom the likelihood test.

D. MUTATION OPERATOR

This theory, a transformation mechanism in which the change likelihood (Pm)is versatile with a solitary chromosome is expressed as:

Pm = 0.1(1 - R). 5

Where R, is a versatile parameter fluctuates in the vicinity of 0 and 1.

At the point when R is little, the transformation likelihood is roughly 0.1. As the estimation of R builds, the new change likelihood esteem diminishes. At long last, when R approaches unit, the transformation likelihood is zero and the new arrangement is the old one. Trials were directed with various estimations of Rand we have discovered that the ideal estimation of R is the normal wellness of the populace. At first ages, the normal wellness esteem is low as we are a long way from the ideal arrangement. In this way, the versatile transformation gives the inquiry space new arrangement components. The normal wellness is enhanced as the GA effectively moves towards a superior arrangement. Finally, the normal wellness approaches the best wellness which is roughly solidarity and the versatile transformation administrator keeps up the best arrangement components.

E. POPULATION REPLACEMENT FUNCTION

This capacity incorporates all GA administrators to create new age of people. It circles to create an equivalent number of kids to the populace measure. In each circle it utilizes the determination work twice to choose two guardians from the present age, and after that produces the new kids that take after the issue requirements. Before the finish of this capacity we add the recently produced people to the populace. At the point when the populace completes its procedure of making new people and after that chooses the best gathering of people

to make due to the people to come. This methodology is known as the rank substitution procedure

V. RESULTS AND DISCUSSION

In this paper, an array synthesis problem is treated as optimization problem, to enable large aperture and complex geometries to be handled with ease. For this situation, a shut shape arrangement does not exist and the arrangement space is wide. In a vast exhibit, it is frequently important to streamline the cluster to control the side-projection levels to abstain from squandering power conveyed to every radio wire component. For this situation, a component can be switched on or off. Embraced in this thesis is the hereditary calculation streamlining technique by recreating the common choice process to acquire an ideal solution. It begins with arbitrarily chose hopefuls as the original. At every development cycle, the Genetic Algorithm sorts the age as indicated by a foreordained execution measure; the execution measure would be the proportion of peak-to-side-lobe level, and afterward disposes of the ones with bring down execution scores. The Genetic Algorithm at that point changes the rest of the contender to create a more current age and rehashes the procedure, until the point when it achieves a stop condition, for example, the most extreme number of ages demonstrates to utilize a hereditary calculation to optimize a 40x40 division reception apparatus. Greatest side-lobe suppression in both azimuth and rise cutis accomplished in figure 2.

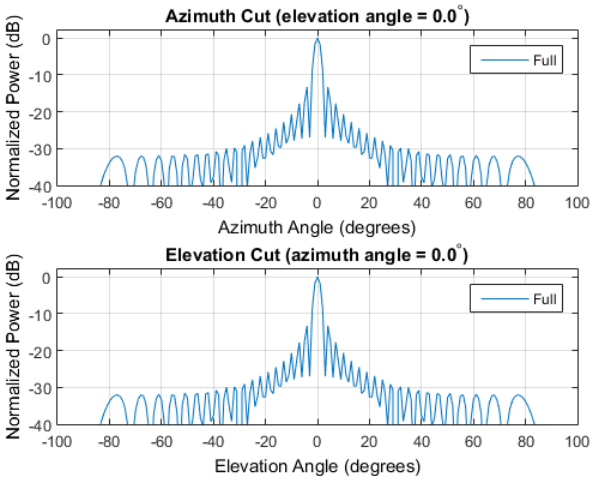

Figure 2: Beam Pattern with Maximum Side-Lobe Suppression

The figure 2 demonstrates the beam design came about because of one run of the mill original applicant. The side-projection level is bring down in azimuth bearing however higher in height heading contrasted with the full exhibit of figure 1. The correct side-projection level and the fill rate of the exhibit is 71.75%; implying that 71.75% of the cluster components are dynamic and the side-lobe level is around 9d

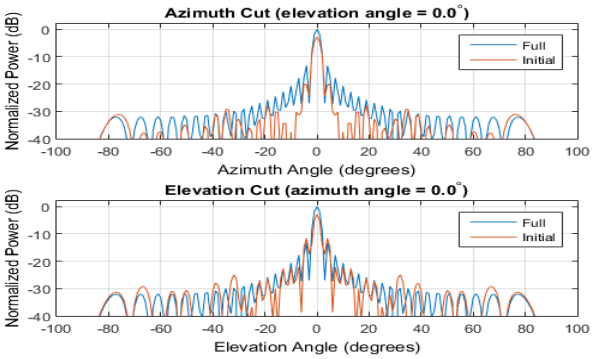

Figure 3: beam pattern of the full and initial patterns

The figure 4 shows the subsequent beam designs. It can be seen that the side-lobe level has been additionally enhanced to around 17.5 dB with a fill rate of 76.5% (of the whole populace considered) Compared to the original competitor; it enhances by 5% more figure 3, while accomplishing extra9 dB side-flap concealment.

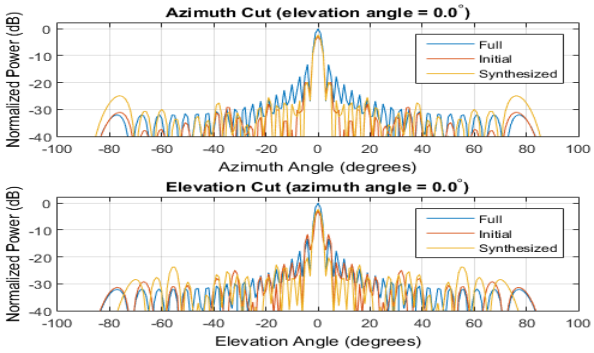

Figure 4: Beam Pattern of the Optimized, Full and Initial Patterns

Figure 5 shows a further improvement of the main lobe (suppression) of the side lobes. The desired pattern and optimized pattern are very similar, at this point; the genetic algorithm considers it as the best specie and terminates the iterative loop. Here the desired optimal value or optimal suppression of the antenna side lobes was achieved. This is projected to lead to an around 25% saving money on the expended influence. Additionally take note of that despite the fact that the optimized cluster utilizes fewer components, the beam width is similar to what could be accomplished with a full array.

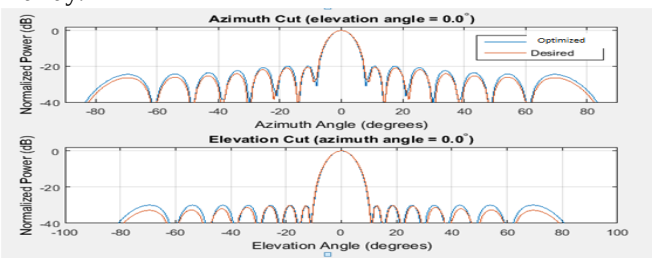

Figure 5: beam pattern of the optimized and desired patterns optimized

VI. CONCLUSION

Optimization of antenna is a giant stride in wireless communication. Optimization is the design and operation of a

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system or process to make it as good as possible in some specific sense and Genetic Algorithm is a phenomenal method in achieving this result. The analysis of optimization of sectorial antenna using Genetic algorithm which Glo sectorial antenna is the case study and a site visit to Glo base station was carried out successfully, the results of the analysis of the research was obtained with the use of MATLAB/Simulink. The outcome of the study shows a high level of improvement with GA. The target is to bring more capacity and improve the network quality without increasing capital expenditure. It can be seen that the side-lobe level has been further improved to about 17.5 dB with a fill rate of 76.5% (1224 dynamic components). Contrasted with the original hopeful, it utilizes 5% more dynamic components while accomplishing extra 9 dB side-lobe suppression. Contrasted with the full exhibit, the subsequent advanced cluster can spare the cost of actualizing Transmit and Receive switches behind sham components, which thus prompts an approximately 25% saving money on the devoured influence. It is found that the Genetic Algorithm gave a similar arrangement in every trial. In any case, all in all the subsequent beam designs share a comparable side-lobe level.

VII. RECOMMENDATION

In other to bring to life this product of this work, it is recommended that a study be cried out to design this product into prototype. And the sectorial antenna used GSM communication should be redesigned for better performance. Obviously, this work may become an indispensable resource to other researchers, institutions and industries for more developments in antenna and wireless communication technology going forward. It is found that the Genetic Algorithm gave a similar arrangement in every trial. In any case, all in all the subsequent beam designs share a comparable side-lobe level.

REFERENCES

[1] Altman, Z., Mittra, R. &Boag, A. (1997) New design of ultra-wideband communication antennas using a genetic algorithm. IEEE Transactions on Antennas and Propagation, vol. 45, no. 10, pp. 1494-1501, 1997.
[2] Altshuler, E. E. & Linden, D. S., (1997). “Wire antenna designs using genetic algorithm”, IEEE Antennas and Propagation Magazine, vol. 39, no. 2, pp. 33-43.
[3] Altshuler, E. E. (2002). “Electrically small self-resonant wire antennas optimized using genetic algorithm”, IEEE Transactions on Antennas and Propagation, vol. 50, no. 3, pp. 297-300.
[4] Balanis, C. A (2002) Antenna Theory and Design, 3rd Edition.
[5] Jin, J. H. Wang, W., Zhu, & Liu, Y. (2006).Array Patterns Synthesizing using Genetic Algorithm. PIERS Online, Vol. 2, No. 1, 6468, 2006.
[6] Liberti J.C., & T.S. Rappaport: (1999.) Smart Antennas for Wireless Communication., Prentice Hall, Upper Saddle River, New Jersey, 1999.
[7] Lu J. &Ohira,T. (2001) Smart antennas at wireless mobile computer terminals and mobile stations, Proc. 2001 IEEE AP-S Int. Symp. USNC/URSI Nat. Radio Sci. Meeting, Boston, July 8–13.
[8] Mangoud, M. A., Dahab, M. A. A., Zaki, A. I. & El-Khamy, S. E. (2003).Genetic algorithm design of compress log periodic dipole array. IEEE 46th Midwest Symposium on Circuits and Systems, vol. 3, pp. 1194-1197.
[9] Pozar, D. M., PCAAD A. (1999.). Personal Computer Aid Antenna Design, Antenna Design Associates. Leverett, MA.
[10] Roy, R. H. (1998).An overview of smart antenna technology: The next wave in wireless communications. Proc. 1998 IEEE Aerospace Conf., vol. 3, May 1998, pp. 339–345.
[11] Yahya, R. S. & Eric, M. (1999). Electronic optimization by Genetic Algorithms. John Wiley, New York, 1999. 31 C. A. Balanis, Antenna theory and analysis