Implementation of Ant Colony Optimization (ACO) in Linear Antenna Arrays for SLL reduction

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***Abstract*— TRM antenna is the one of the component of the Wireless System Network. It is used in Wireless network to improve the throughout and efficiency of the network. The TRM antenna is used in satellites, SONAR for acquisition of signals. Due to large number of arrays presents, sometimes TRM antenna failure takes place. When a transmitter/receiver module (TRM) error occurs, the beam pattern is distorted. In this case, resynthesizing the optimal beam pattern with all functioning TRMs, without failed TRM, is preferable to TRM repair or replacement. The degradation of the capacity of transmitter/receiver module (TRM) distorts the beam pattern; that is, the side lobe level (SLL) increases. Lot of research has been done on the optimization of the antennas, but the focus will be on the usage of ACO. Firstly, antenna failure takes place. Then compensation will be done by using ACO and the whole simulation will be shown in MATLAB environment.**

***Keywords*— Antenna Arrays, Linear arrays, ACO, MATLAB, SLL reduction**

I. INTRODUCTION

In WSN systems antenna is the one of the most useful component to enhance the system capability. Antenna array took place in various applications like satellite communication, SONAR, etc [1]. These type of antennas are basically embedded outside to acquire the images. There are number of factors that degrade the performance of the network like semi- conductors, RF circuits and even whole system. Antenna consists of large number of radiating elements in group. When one of the radiating material gets distorted then failure of antenna gets occurred. The failure in this give rise to increased level of SLL [2, 3].

TRM antenna is the one of the component of the Wireless System Network. It is used in Wireless network to improve the throughout and efficiency of the network. The TRM antenna is used in satellites, SONAR for acquisition of signals. Due to large number of arrays presents, sometimes TRM antenna failure takes place. When a transmitter/receiver module (TRM) error occurs, the beam pattern is distorted. In this case, resynthesizing the optimal beam pattern with all functioning TRMs, without failed TRM, is preferable to TRM repair or replacement The degradation of the capacity of transmitter/receiver module (TRM) distorts the beam pattern; that is, the side lobe level (SLL) increases [4, 5, 6].

II. BASIC THEORY

TRM antenna is the one of the component of the Wireless System Network. It is used in Wireless network to improve the throughout and efficiency of the network. The TRM antenna is used in satellites, SONAR for acquisition of signals. Due to large number of arrays presents, sometimes TRM antenna failure takes place. When the TRM error occurs, then beam pattern gets distorted. It is necessary for the replacement of the TRM when antenna array distortion gets occurred. When TRM gets distorted then SLL level gets increased. To recover this, there is strong need of transmission medium so that no communication gets distorted [7, 8].

That is why, in proposed work, a new optimization algorithm will be developed for reduction of SLL and ACO algorithm is proposed in this work. The performance of the proposed technique will be evaluated on the basis of parameter such as gain, SSL reduction and directivity.

ACO algorithm is an original intellectual optimization algorithm imply the winged animal swarm practices, which was planned by analyst Kennedy and Dr. Beernaert in 1995. In ACO answer, every individual is called "Burrowing little creature COLONY", which speaks to a potential arrangement.

The calculation attains to the best arrangement with the variability of a few particles in the following space. An ANT COLONYs seek in the arrangement space captivating after the best ANT COLONY by altering their positions and the wellness oftentimes, the airborne course and speed are controlled by the object function.

III. RELATED WORK

Narwant S. et.al 2012 [9], has tended to the issue of beam pattern utilizing Firefly Algorithm (FA) by controlling just the sufficiency excitation of exhibit components. A wellness capacity has been detailed to get the blunder between pre-fizzled (unique) sidelobe design and measured side lobe example and this capacity has been minimized utilizing FA. Numerical case of expansive number of component disappointment revision is displayed to demonstrate the ability of this adaptable methodology.

Singh Gurpreet, Singh Maninder 2014 [10], proposed a method based on PSO when then compared with genetic algorithm for optimized algorithm. In the end finally comparison is made between GA and PSO.

Gurpreet et.al, 2015 [11], presented that TRM array antenna is working in wireless communication networks. There are plentiful of drawback that can take place although the transmission of the data. The furthermost imperative drawback is of antenna is specifically its failure. In an active antenna array, as soon as a small number of components doesn't work attributable to some specific issues. So, Genetic Algorithm is executed and then coordinated with Particle Swarm Optimization intended for linear array synthesis on behalf of far field side lobe indentation utilizing amplitude individually to acquire the anticipated radiation sample with the help of stated SLL.

R. Muralidharan et.al 2015 [12], presented a technique based on quantum particle swarm optimization for failure correction of a linear array of parallel half-wave length dipole antennas with fixed side lobe level and desired minimum return loss. Mutual coupling effect between the antenna is also considered in the simulation. The paper also takes care of matching between antenna and the feed network by maximizing the minimum return loss.

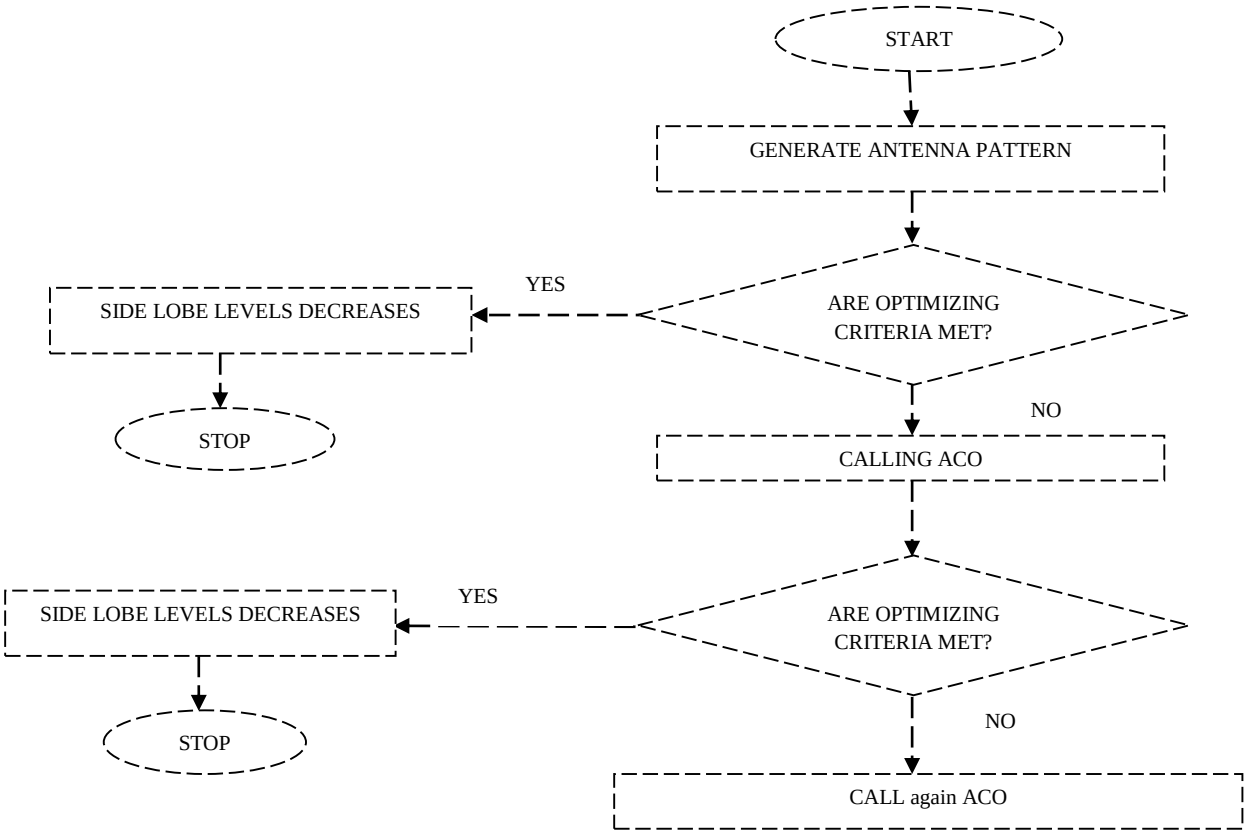

Figure 1: Flowchart

IV. SIMULATION WORK

Firstly, we generate a pattern for antenna. After optimization, we will check if there is decrease in side lobe levels using ACO. If it is optimized and level of SLL decrease then the process will stop. When a transmitter/receiver module (TRM) error occurs, the beam pattern is distorted. In this case, resynthesizing the optimal beam pattern with all functioning TRMs, without failed TRM, is preferable to TRM repair or replacement The degradation of the capacity of transmitter/receiver module (TRM) distorts the beam pattern; that is, the side lobe level (SLL) increases. So optimization is necessary. In this step call to ACO will be done in which the effect of SLL will be reduced using fitness function in which only that nodes will be consider that helps in enhancing the accuracy of the network not in degradation of the network. ACO is one of the most advance techniques which is getting used world wide web for each and every purpose. ACO has been used for the optimization of the TRM antenna failure. During the operation of an array antenna system, TRM failure can occur at any time. When a TRM failure occurs, the TRM is supposed to be turned off. Then implementation of optimization method takes place. ACO algorithm is a class of Evolutionary Algorithm via natural selection that works on the principle of survival of the fittest.

V. RESULT ANALYSIS

The whole simulation is being done in MATLAB 2010a environment using various metrics as shown below;

1. Throughput

Throughput is the rate of invention or the rate on which a bit can be processed. When used in the framework of communication networks.

2. Routing overhead

It is the ratio between the numbers of sent routing packets over the number of received data packets.

3. Side Lobe Level

When antennas are arranged in linear side then it is called linear arrays otherwise parallel arrays. They emit radiations in different angles. So now when direction of lobes gets distorted it is called distortion and it must be similar to main lobe directions.

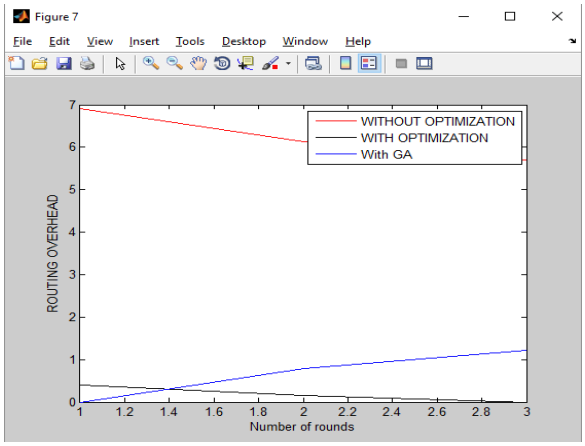

Figure 2: Routing Overhead

The above fig. 2 shows the routing overhead with the significant network density. During the transmission the routing overhead value increases from 25 to 56.

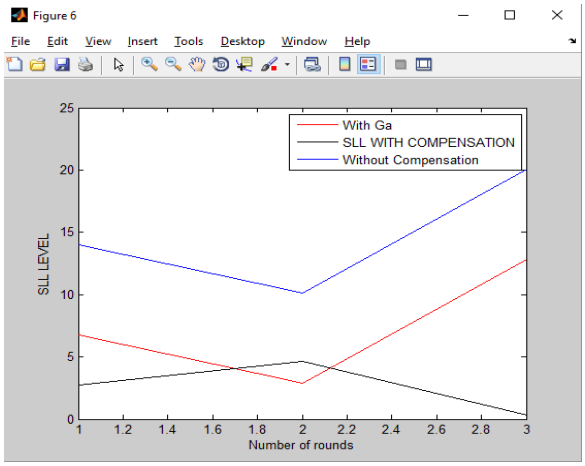

Figure 3: SLL Level

The fig. 3 shown above describes the side lobe level of the signal whose units have been described on their axis .This is the uncompensated structure with distortion. The y axis is the side lobe level and the x axis represents number of iterations. At the y axis, it represents 15 db of SLL.

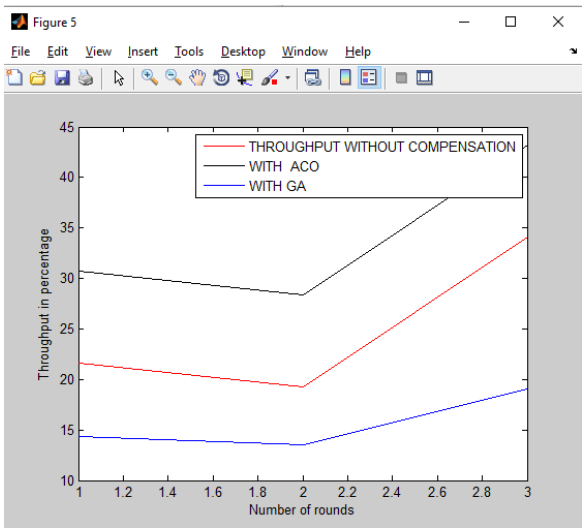

Figure 4: Throughput

Throughput is the number of nodes sent over the network in given time without congestion. The above figure shows the throughput value. It has been seen that value of throughput is being enhanced in the figure. The value of Throughput w.r.t nodes varies from .1% to 34% in Fig.4.

VI. CONCLUSION AND FUTURE SCOPE

There are numerous benefits towards a linear array system. These also consist of great reliability, high beam agility, stress-free maintainability, as well as multi-beam multi-target applications. The shortcomings take account of inflexibility in adding new frequencies, much higher price at the present-day, convolution of multi-frequency operations, and lower gain at lower elevations for a linear array antenna. The technology hazards in addition to the cost drivers embrace, first and foremost, the T/R modules then the beam-forming network architecture and after this implementation. We propose that, as a proof of concept demonstration, a small linear array antenna be built and tested, in order to prove the maturity of the concept and in the direction of working out the impending issues at the T/R module as well as the beam-forming stages, for achieving a ACO level performance. So ACO will produce the best alternate path when one antenna fails to transmit the number of data packets.

REFERENCES

[1] Stephen Jon Blank, "On the Empirical optimization of Antenna Arrays", IEEE antenna and Propagation Magazine, Vol. 47, 2, pp.58-67, April 2005.

[2] M.A.Panduro, "Design of Non-Uniform Linear Phased Arrays using Genetic Algorithms To Provide Maximum Interference Reduction Capability in a Wireless Communication System", Journal of the Chinese Institute of Engineers, Vol.29 No.7, pp.1195-1201, 2006.

[3] Peter J.Bevelacqua and Constantine A.Balanis, "Optimizing Antenna Array Geometry for Interference Suppression", IEEE Transaction on Antenna and Propagation, Vol.55, no.3 pp. 637-641, March 2007.

[4] T. Panigrahi, A. Patnaik, S. N. Sinha, C. G. Christodoulou, "Amplitude Only Compensation for Failed Antenna Array Using Particle Swarm Optimization", IEEE, 2008.

[5] U. Singh, H. Kumar and T.S.Kamal, "Linear array synthesis using Biogeography based optimization", Progress In Electromagnetics Research M, vol. 11, 25-36, 2010.

[6] Jung-Hoon Han, Sang-Ho Lim, Noh-Hoon Myung, "Array Antenna TRM Failure Compensation", Using Adaptively Weighted Beam Pattern Mask Based on Genetic Algorithm Antennas and Wireless Propagation Letters, IEEE, 2011.

[7] T.S. Jeyali Laseetha, R Sukanesh, "Synthesis of linear antenna array using Genetic Algorithm to maximize side lobe level reduction", International Journal of Computer Application, Vol.20, No 7, April 2011.

[8] Jung-Hoon Han, Sang-Ho Lim, and Noh-Hoon Myung, "Array Antenna TRM Failure Compensation Using Adaptively Weighted Beam Pattern Mask Based on Genetic Algorithm", IEEE Antennas And Wireless Propagation Letters, Vol. 11, pp. 18-21, 2012

[9] Narwant S. Grewal, MunishRattan, Manjeet S. Patterh, "A linear antenna array failure correction using firefly algorithm", Progress in electromagnetic Research, vol.27, pp.241-254, 2012.

[10] Singh Gurpreet, Singh Maninder, "TRM Array Antenna Failure Compensation Using Extended PSO", IOSR Journal of Electronics and Communication Engineering (IOSR-JECE), Vol. 9, Issue 1, pp. 61-68, 2014.

[11] Gurpreet Singh, Anita Kumari, "A Hybrid Approach for SLL Reduction in Phase Array Antenna Using Combination BFO-PSO and BFO-GA", IJRECE, Vol. 3, 2015.

[12] R. Muralidharan, A. Vallavaraj, G.K. Mahanti, Hemant Patidar, "QPSO for failure correction of linear array of mutually coupled parallel dipole antennas with desired side lobe level and return loss", Journal of King Saud University, Springer, 2015.