Performance Analysis of Smart Antenna using Particle Swarm Optimization Algorithm

Shravan Kumar Namdeo[1], Dr. Pramendra Tilanthe [2]

[1](Electronics and Communication, SDBCT/ RGPV, India)
[2](Electronics and Communication, SDBCT/ RGPV, India)

Abstract

The smart antennas are antenna arrays with smart signal processing algorithms used to identify spatial signal signature such as the direction of arrival (DOA) of the signal, and one of the most important processes is beam forming. In the most important function in beam forming is changing beam pattern of antenna for a particular angle with minimize side lobe level . Particle Swarm Optimization algorithm is use for the beam forming. In the particle Swarm Optimization algorithm, a set of position and velocity for angles and amplitudes of antenna currents has been generated to optimized solution in desired direction. By using this method the side lobe interference will be reduced. The implementation result shows that the system a good performance.

Keywords: *Smart antenna, PSO, Phase angle, DOA, etc*

I. INTRODUCTION

The advent of technology and recent developments in communication, wireless communication has reached to new level. 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 antenna array for wireless communication was first initiated in decade of 1940 [2]. This was the prominent development as it has enabled antenna structure to receive transmit information from any direction without any structure movement. Smart antenna systems basically act as the switched beam type, communicate directionally by forming specific antenna beam patterns thereby selecting one of the weighted combinations of antenna outputs with the greatest output power in the remote user's channel [4]. The paper is organized as follows. Sect. II describes the model of smart antenna. In Sect. III is described implementation of smart antenna using PSO method. In Sect. IV show the simulation result of side lobe reduced and angle direction moved. In Sect. V show the conclusion.

II. THE SMART ANTENNA

The Smart antenna consists of an antenna array, combined with signal processing in both space and times. It overcomes the problem of limited channel bandwidth, and satisfying a growing demand for a large number of mobiles on communications channels. A Smart antenna help in improving the system performance by increasing channel capacity and spectrum efficiency, steering multiple beams to track many mobiles, compensating electronically for aperture distortion, extending range coverage. To steer the main beam, according to the direction of arrival of desired signal, in adaptive beam forming is control by the values of weight vector. It finds the optimum values of these weight vectors adaptive algorithms are used. These use beamforming algorithms to identify spatial signal signature and is used to compute beamforming vectors to track the antenna beam on receiver point. Smart antennas enhance system performance, coverage and spectrum efficiency, channel capacity. Smart antennas use efficient methods to track multiple users and reduce interferences.

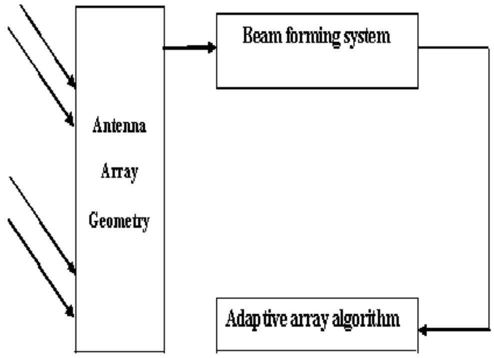


Fig 1 Block Diagram of Smart Antenna System

The smart antenna radiation pattern nullifies the interference signal angle of arrival and direct the beam towards the desired (wanted) signal angle of arrival, by this the capacity of the system is improved and this process also leads to maximize the Signal to Interference Ratio, indeed maximizes the throughput of the network [9].

Smart antenna system are divided in to two types

i. Switched Beam Smart Antenna
ii. Adaptive Beam Smart Antenna

III. OPTIMIZATION

The PSO as an optimization tool provides a population-based search procedure in which individuals called particles change their position (state) with time. In a PSO system, particles fly around in a multidimensional search space. During flight, each particle adjusts its position according to its own experience (This value is called $Pbest$), and according to the experience of a neighboring particle (This value is called$Gbest$), made use of the best position encountered by itself and its neighbor. A Particle swarm optimization is a relatively recent heuristic search method whose mechanics are inspired by the swarming or collaborative behavior of biological populations. in Particle Swarm Optimization algorithm is similar to the Genetic Algorithm in the sense that these two evolutionary heuristics are population-based search methods. The other words, Particle Swarm Optimization algorithm and the Genetic Algorithm move from a set of points (population) to another set of points in a single iteration with likely improvement using a combination of deterministic and probabilistic rules. The Genetic Algorithm and its many versions have been popular in academia and the industry mainly because of its intuitiveness, for ease of implementation, and the ability to effectively solve highly nonlinear, and mixed integer optimization problems that are typical of complex engineering systems. In drawback of the Genetic Algorithm is its expensive computational cost. The performance comparison of the GA and PSO is implemented using a set of benchmark

The implementation of PSO in optimal reliability planning the optimal reliability planning model formulated as a non-linear optimization problem can be solved using the PSO algorithm as follows

Step 1: In this step initialize the Particle Swarm Optimization parameters such as

Population size
Maximum number of generations,
Number of variables

$C1$, $C2$, w_{min} and w_{max} and read the problem parameters like line data, bus data, upper and lower limits on forced outage rate of system components and system EDNS. First we decide the population size after the population size find maximum number of generation

Step 2: In this step we Set the forced outage rate of components of the composite system as unknown state variable $X\ (j), j = 1 \ldots \ldots n.$
Where n is total number of generators and transmission lines in the system. State variable X(j) depend on the j and j vary from 1 to n

Step 3: In this step set the generation counter t for generation of m particle

$$\{x_i\ (j)\ , i = 1,2,3, \ldots \ldots \ldots \ldots \ldots \ldots \ldots . . m; j\}$$

Step 4: Evaluate the fitness of each particle according to the objective function and check the constraint violations of each particle.

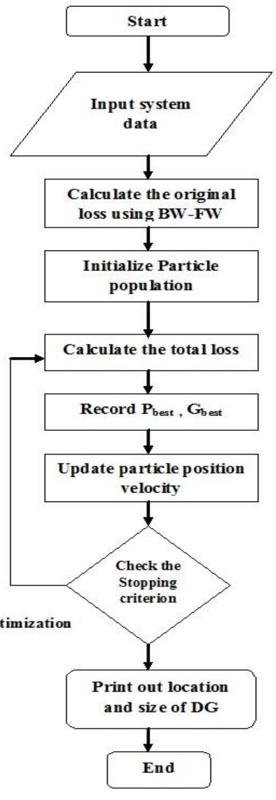
Step 5: Form $pbest$ set from each particle and assign $gbest$ from the $pbest$ set

Step 6: Update the generation counter$t = t + 1$.

Step 7: Using the global best and the individual best of each particle, the ith particle velocity in the jth dimension given by updated.

Step 8: Based on the updated velocities, each particle changes its positions as Xtþ1 i. If the particle violates its position limits in any dimensions then set its position at the proper limit and do steps 4 and 5.

Step 9: When any of the stopping criteria is satisfied, stop the algorithm or else go to step 6.



Particle Swarm optimization

IV. RESULT

The antenna array has been simulated for 5 antennas for frequency 2.4 GHz. The electrical steering has been achieved successfully. The antenna pattern for steer pattern is given as follows,

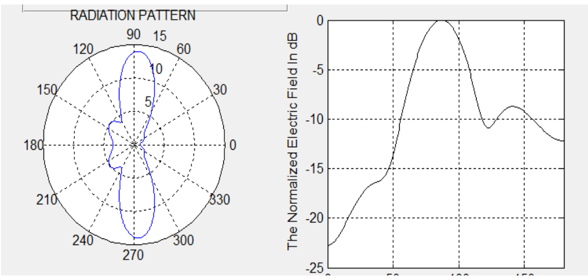


Fig-2 The Optimization of Radition Patteren with Number of Element N=5 And Desired Direction for Main Beam Is 90 Degree With PSO Method

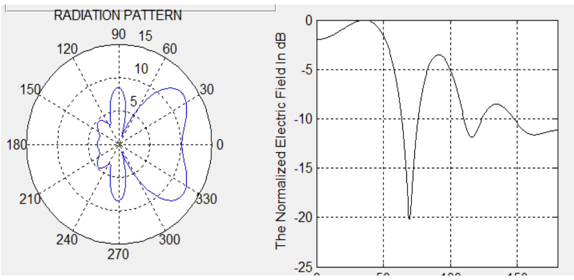


Fig-3 The Optimization of Radition Patteren With Number of Element N=5 fnd Desired Direction for Main Beam Is 30 Degree With PSO Method

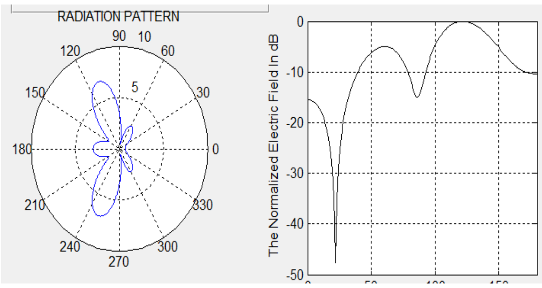


Fig-4 The Optimization of Radition Patteren with Number of Element N=5 and Desired Direction for Main Beam is 120 Degree With PSO Method

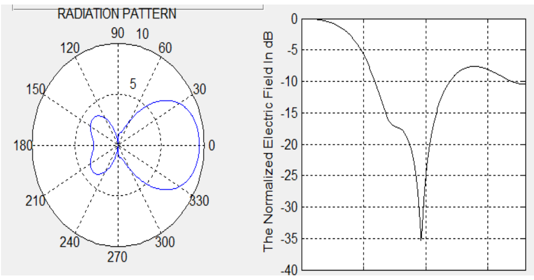


Fig-5 The Optimization Of Radition Patteren With Number Of Element N=5 And Desired Direction For Main Beam Is 20 Degree With PSO Method.

Table. 1- Optimize Side lobe level by PSO

S.No.	Angle In Degree	Side Lobe Lavel
1	90	-8 db
2	30	-3 db
3	120	-5 db
4	20	-17 db

V. CONCLUSION

In this paper Particle Swarm Optimization (PSO) is used to locate the beam pattern desired direction with minimize Side lobe level. Using this technique reduced side lobe and moved angle array direction

REFERENCES

[1] Amara prakasa rao, “Adaptive Beamforming Algorithms for Smart Antenna Systems”, Volume 13, 2014.

[2] Revati Joshi, Ashwinikumar Dhande, “Performance and Quality Analysis of Adaptive Beamforming Algorithms (LMS,CMA, RLS & CGM) for Smart Antennas”, Volume: 03 Issue: 05 | May-2014,

[3] K.Ramakrishna, “A Novel Adaptive Beam forming RLMS Algorithm for Smart Antenna System”, Volume 86 – No 5, January 2014

[4] Susmita Das, IEEE Member, “Smart Antenna Design for Wireless Communication using Adaptive Beam-forming Approach” Volume 2008.

[5] Kapil dungriyal, “performance of mir-lms algorithm for adaptive beam forming in smart antenna”, Proceedings of IRF International Conference, Chennai, India, 20th April. 2014, ISBN: 978-93-84209-07-0.

[6] D. M. Motiur Rahaman,” Least Mean Square (LMS) for Smart Antenna”, Universal Journal of Communications and Network 1(1): 16-21, 2013.

[7] Chhaya Singh, B G Hogade “Implementation of an Adaptive Beam Forming Antenna for Radio Technology”, Volume-2 Issue-9, August 2014.

[8] Neelapu G R Reddy, “Smart Antennas Adaptive Beamforming through Statistical Signal Processing Techniques”, International Journal of Research in Computer and Communication Technology, Vol 2, Issue 8, August - 2013.

[9] Ioan Nicolaescu, “Smart antennas for wireless communications systems”.

[10] Dale J. Shpak, “A method of optimal pattern synthesis of linear arrays with prescribed nulls”, IEEE transactions on antenna and propagation, Vol. 44, No.3, March 1996.

[11] Constantine A. BALANIS, “Antenna theory: analysis and design” Third edition, John Wiley & sons Inc., 2005.

[12] Steyskal, H., R. A. Shore, and R. L. Haupt, “Methods for null control and their effects on the radiation pattern,” IEEE Trans. Antennas Propagat., Vol. 34, 404–409, 1986.

[13] Guney, K. and A. Akdagli, “Null steering of linear antenna arrays using modified tabu search algorithm,” Progress In Electromagnetics Research, PIER 33, 167–182, 2001.