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PERFORMANCE COMPARISON OF THE SMART ANTENNA USING PSO AND BB-BC BASED OPTIMIZATION TECHNIQUE

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ABSTRACT

The electromagnetic power is an important term for wireless communication system. Which tells about the efficiency of the communication and its life in case of battery based communication setup. The reception in the desired direction is important for communication architecture. Hence the directivity and side lobes levels are two important parameters in the antenna system of wireless communication. In this paper the side lobes level reduction with the evolutionary optimization techniques has been given. PSO and BBBC techniques have been used for optimization. The optimization curve and resulted side lobes level are discussed in the result section of the paper. The BB-BC technique has showing superior results compare to PSO technique.

KEYWORDS: Antenna array, BB-BC, PSO, directivity etc.

INTRODUCTION

With 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. The use of smart antennas is one of the vital characteristic that has led to third and fourth generation standard antenna developments. The smart antenna theory always driven by the Antenna array and so do the wireless communication technique. With antenna pattern synthesis there comes speed and robustness to the existing system thereby improvising transmission parameters. The along with this radio wave propagation is a matter of research that accounts to faster and reliable transmission scheme, since wireless system is generated from the roots of radio communication system. Radio communication was first came into existence in December , 1901 when Guglielmo Marconi successfully received the first transatlantic radio message. The message under radio communication was letter 'S' which is considered as the most significant approach in developments of radio communication. Now, the antenna arrays could be used to mitigate intentional interference or unintentional interference directed toward the communication system. Intentional interference here refers to jamming while unintentional interference refers to radiation from other source that is not meant for the communication system. With more research in the field to optimize and improvise the antenna array performance, there came adaptive antenna concept. These antenna array were capable of adapting signal radiations pattern as per the environment factors they are operating in, a one more milestone in wireless communication.

RELATED WORK

Susmita Das, in this paper, smart antenna is recognized as promising technologies for higher user capacity in 3G wireless networks by effectively reducing multipath and co-channel interference. It is powerful, and low-cost, digital processing components and the development of software-based techniques have made smart antenna systems a practical reality for both BS and mobile station of a cellular communications scheme in the next generation. The core of smart antenna is the selection of smart algorithms in adaptive array. Using beam forming algorithms the weight of antenna arrays can be adjusted to form certain amount of adaptive beam to track corresponding users automatically and at the same time to minimize interference arising from other users by introducing nulls in their directions. It increase network capacity by precise control of signal nulls quality
and mitigation of interference combine to frequency reuse reduce distance, improving capacity. It provides better range or coverage by focusing the energy sent out into the cell, multi-path rejection by minimizing fading

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and other undesirable effects of multi-path propagation. Research into smart antenna technologies has increased tremendously to keep pace with the constantly expanding needs of the wireless communications industry **[1].**

Amara Prakasa Rao, in this paper in study, various evolutionary algorithms are used to adaptive the weights of the smart antenna arrays to maximize the output power of the signal in desired direction and minimise the power in the unwanted direction signal. In Least Mean Square algorithm, the convergence speed of the algorithm depends on the step size, which depends on the correlation matrix. With large Eigen values spread, it converges slowly in a dynamic channel environment. Simulation results show that the better adaptive Beamforming algorithms for smart antenna systems in mobile communications. The convergence speed of the LMS algorithm depends on the Eigen values of the correlation matrix. With the large Eigen values spread it converges slowly in a dynamic channel environment. This problem is solved by RLS algorithm. Both the cases need the reference signal **[2].**

ANTENNA ARRAY

An antenna array is a set of N spatially separated antennas. In the most commonly antenna with N=2 elements are considered as array of antenna. An array of antenna can have number of elements which may include various thousand elements. The antenna array is preferred over single antenna as it has ability to filtrate the intentional electromagnetic radiation in the air.

The consider a linear array of n isotropic elements of equal amplitude and separated by distance d. in the total field E at a far field point P in the given direction φ is given by,

$$H = 1 + \frac{e1}{\psi} + \frac{e2}{\psi} + \frac{e3}{\psi} + \cdots \ldots \ldots \ldots \ldots \ldots + en\frac{1}{\psi} \tag{1}$$

where , ψ = total phase difference of the fields from adjacent sources.

$$\psi = 2\Pi \left(\frac{d}{\lambda}\right) \cos\varphi + \alpha \tag{2}$$

α is the phase difference between excitation current of adjacent element of antenna array. The location of the nth antenna element is described by the vector dn , where

$$dn = [xn\ yn\ zn] \tag{3}$$

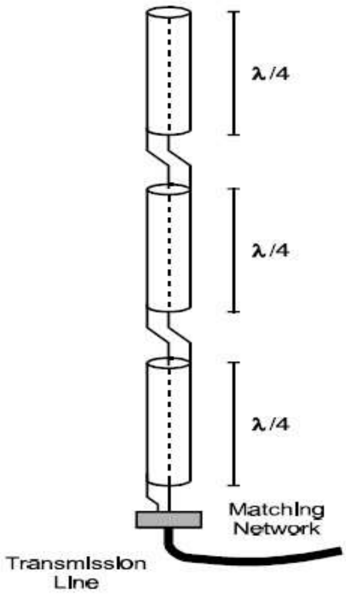

Fig:1 Antenna Array

The array factor for, N number of elements

$$AF = \sum_{n=1}^{N} E_n = \sum_{n=1}^{N} e_n{}^{jk} \tag{4}$$

Where En $=e_n^{jK}$ and K= (nkdcosθ + βn) is the phase difference. βn is the phase angle. Antenna array can be used to:

- It increases the overall gain of the transmission.
- "Steer" the array so that it is most sensitive in a particular direction

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- It helps to determine the direction of incoming signals
- Maximize the Signal to Interference Plus Noise Ratio (SINR)
- Cancel out interference from a particular set of directions
- Provides diversity reception

PARTICLE SWARM OPTIMIZATION

Particle Swarm Optimization (PSO) is a relatively recent heuristic search whose mechanics are inspired through the swarming or collaborative behavior of biological populations. PSO is similar to the Genetic Algorithm (GA) in the sense that these two evolutionary heuristics are population based search technique. In other words, PSO and the GA move from a set of points (population) to another set of points in a single iteration with likely improvement using the combination of deterministic and probabilistic rules. For the Genetic Algorithm and its many versions have been popular in academia and the industry mainly because of its intuitiveness, ease of implementation, and the ability to effectively solve highly nonlinear, and mixed integer optimization problems that are typical of complex engineering systems. The drawback of the GA is its expensive computational cost. The performance comparison of the GA and PSO is implemented using a set of benchmark.

BIG BANG BIG CRUNCH

The side lobe level reduction is the prime motive of the system. The optimization of the antenna current of each element is required to reduce the sidelobe level. Let the initial antenna current is [I1 I2 ……. In] , field due all antenna may be given as

$$H = H1 + H2 + H3 + \cdots \ldots Hn; \tag{5}$$

Where Hi is the magnetic field due to ith node of antenna array.

$$Hi \;\; \alpha \;\; Ii \tag{6}$$

The normalized H will contain the information of beam pattern
is side lobe levels in beam pattern ,then the objective is minimize the cost function given as

$$C.F. = maximum([As1, As2, \ldots.]), \tag{7}$$

The Big Bang – Big Crunch (BB-BC) algorithm is a heuristic population-based evolutionary optimization method. Among the merits of this method are computational simplicity, ability to handle multidimensional problems with very fast convergence. However, it seems that the implementation of it can be problematic when a noisy multimodal functional space is encountered, where there are a few local minima or maxima of a similar magnitude. The optimization problem can be stated as extreme-value problem where the main objective is to find such a set of parameters (x1, x2, . . . , xn) which maximize or minimize a quantity dependent upon them.

RESULTS AND DISCUSSION

Un-optimized antenna array

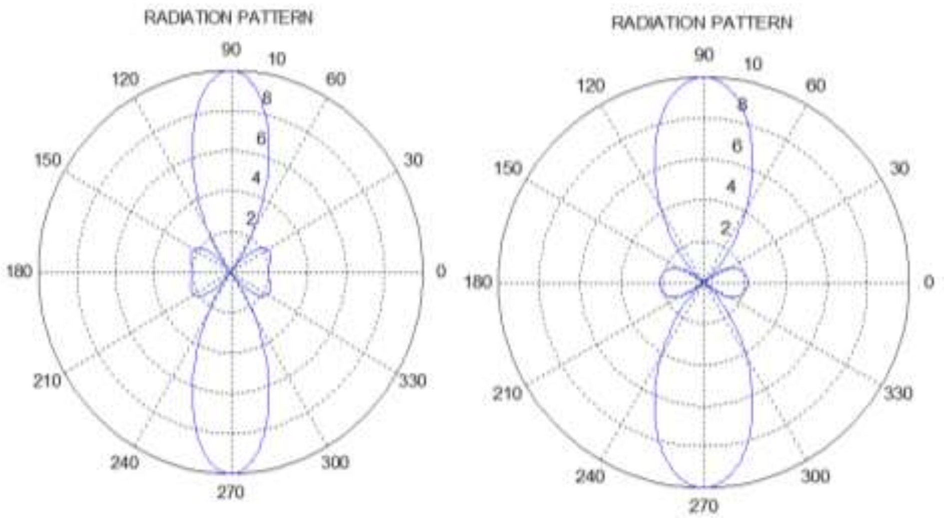

Fig: 2 Radiation pattern for frequency a) 2.4 GHz ,b) 2 GHz

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Table: 1 Performance Parameter of without optimization

S.No.	Freq.	DIRECTIVITY	SIDEBAND POWER LEVEL
1	2.4 GHz	10.1	-12.9 dBc
2	2 GHz	9.3	-13.43 dBc

PSO based optimization:

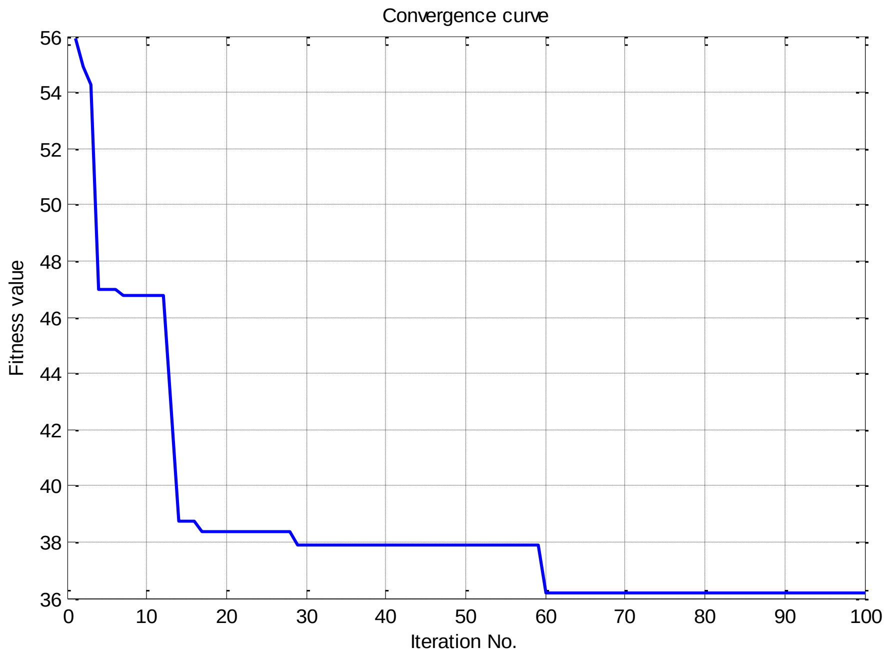

Fig: 3 PSO Based Typical convergence Curve

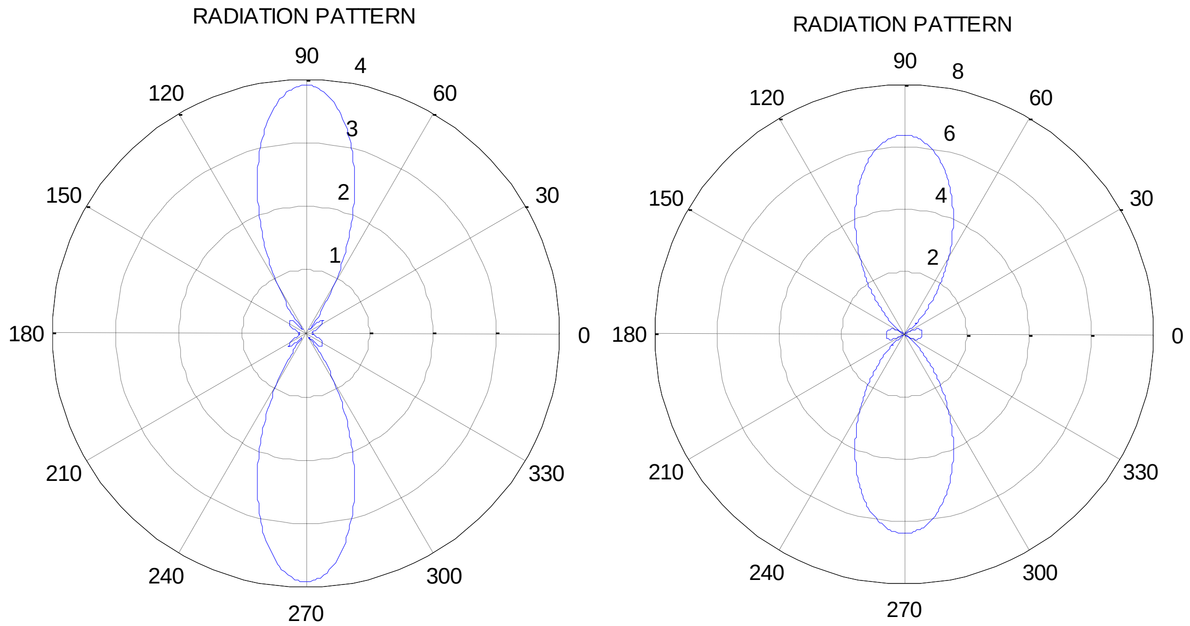

Fig: Radiation pattern using PSO for frequency a) 2.4 GHz ,b) 2 GHz

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Table: 2 Performance Parameter of PSO

S. No.	Freq.	DIRECTIVITY	SIDEBAND POWER LEVEL
1	2.4 GHz	10.61	-20.1
2	2 GHz	9.42	-20.8 dBc

<u>BB-BC based optimization:</u>

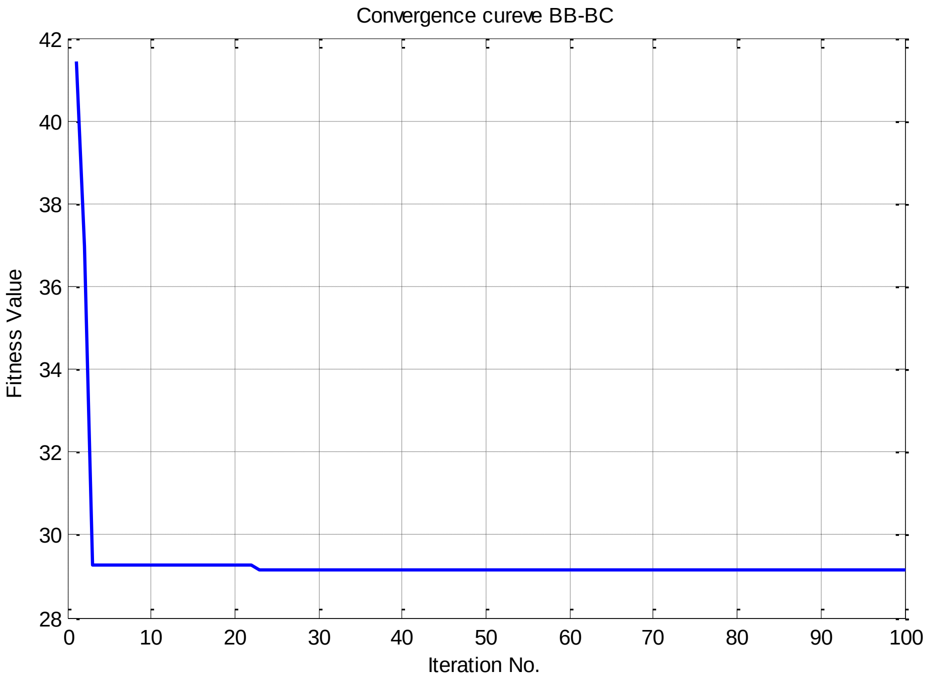

Fig: Performance of Convergence Curve BB BC

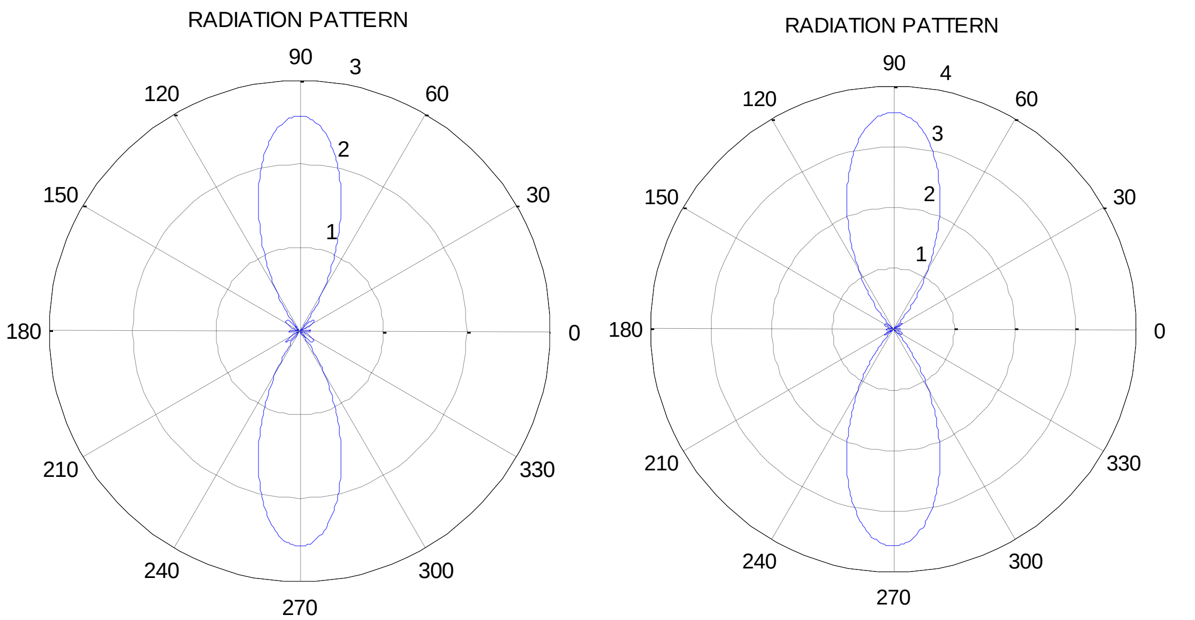

Fig: Performance of Radiation Pattern With BB BC

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Table: 3 Performance Parameter of BB BC

S. No.	Freq.	DIRECTIVITY	SIDEBAND POWER LEVEL
1	2.4 GHz	10.9	-21.5 dBc
2	2 GHz	10.36	-23.9 dBc

CONCLUSION

The sideband power level is significantly reduced ~ 8-10 dB with optimization level. About 5 % power is going in unused sidebands without optimization which ~ 10 times reduced by optimization. The optimization using PSO and BB-BC has been carried out for frequency 2 and 2.4 GHz. It is found the BB-BC has performed better than PSO. It performs better not only in the power level but also in the time. It required only 22 iteration for convergence whereas PSO requires more than 50 iteration.

REFERENCES

[1] Susmita Das, IEEE Member, "Smart Antenna Design for Wireless Communication using Adaptive Beam-forming Approach" Volume 2008.
[2] Amara prakasa rao, "Adaptive Beamforming Algorithms for Smart Antenna Systems", Volume 13, 2014.
[3] 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.
[4] Yahia Rahmat-Samii and Eric Michielssen, "Electromagnetic Optimization by genetic algorithms", John Wiely & Sons, Inc, 1999.
[5] Ahmed Magdy, K. R. Mahmoud, and S. Sayed, "Cooperative Communications Based on Smart Antenna Systems Using PSO Algorithm", PIERS Proceedings, Stockholm, Sweden, Aug. 12{15, 2013.
[6] M. Gomez-Gonzaleza, A. Lopezb, F. Jurado, "Optimization of distributed generation systems using a new discrete PSO and OPF", Electric Power Systems Research, 2012.
[7] S. Sakthivel, S. Arun Pandiyan, S. Marikani, and S. Kurinji Selvi, "Application of Big Bang Big Crunch Algorithm for Optimal Power Flow Problems", The International Journal Of Engineering And Science (IJES) Volume 2, pp. 41-47, Issue 4, 2013.

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