Design, Development and Characterisation of Microstrip Patch Antenna using Optimisation Schemes: A Perspective

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Abstract – The natural optimization technique is mimicry of natural phenomenon and is a soft computing approach that has many engineering applications. In this paper the an introduction is drawn of various schemes and its implementation is performed on practical microstrip patch antenna design using Bacterial Foraging Algorithm (BFO) Here, design of microstrip patch antenna using optimization technique is done. The schemes like Bacterial Foraging, Ant colony and particle swarm optimization are discussed. The various schemes are endowed with fitness level and are evolutionary in nature.

Index Terms – Particle Swarm optimization (PSO), Ant colony optimization (ACO), Bacterial Foraging optimization (BFO), Microstrip Antenna, Feed point.

1. INTRODUCTION

The intelligent biomimicry and its collection of various techniques available in nature provides various indications on which replica can be made, these replica provide source of optimization and its application in various core area of engineering will be helpful and beneficial for replacing the conventional optimization approaches. The outlook of optimization is Swarm intelligence (SI), the discipline of which is an artificial intelligence (AI), is aim is to design of intelligent multi-agent systems by the source of inspiration of living beings involved in collective behavior such as wasps, ants, termites and bacteria as well as from other animal societies such as flocking of birds or sanctuaries of fishes. The behavior of ant colonies have always fascinate researchers of cooperation in various arenas the goals set are self- organized and without social control if any. The swarm intelligence can be operated in various applications of engineering that involves complex mathematical problem and will be replacement to LMS method. The pattern for optimum results focus attention to Particle swarm optimization (PSO)[1] is the process to move on best solution in complex problems. The situation of behaviorism in exemplified by homogeneity, Locality, Collision avoidance, Velocity matching and Flock centering. The main aim will be behavioral, flocking, avoiding collision, matching and cohesion. The technique is based on foraging (search for food). Bacterial foraging is a concept that has been discovered by K.M.Passino in year 2002[2]. Bacteria search for food in such a way that the maximum energy is preserved movement of bacteria consumes energy; so it moves in best-optimized path to gain more energy than it loses. The optimized path that is being used by bacteria forms the basis for new optimization algorithm i.e. Bacteria foraging technique, which can be used in optimizing many Engineering problems. In this paper, this optimization scheme is used in Microstrip antenna design for feed point determination.

2. ANT COLONY OPTIMIZATION (ACO)

Ants navigate from nest to food source. The Ants while performing search move in Shortest path and its discovery is via pheromone trails despite being blind[3][4]. The movement at random pheromone and its deposition increases the path being followed. The movement of ant is taken as baseline for optimization. The two condition are taken into account straight line and second with hindrance. The ants when move in straight line and when obstacle is fancied it take different path

The path movement will be attributed to

a) Straight path.

b) Left path

c) Right Path.

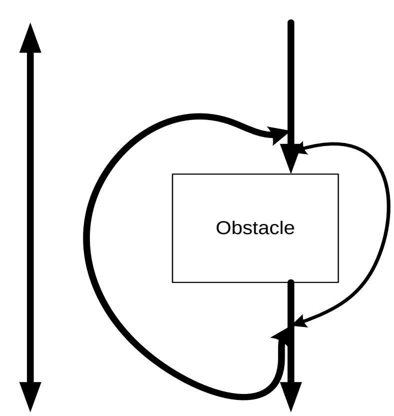


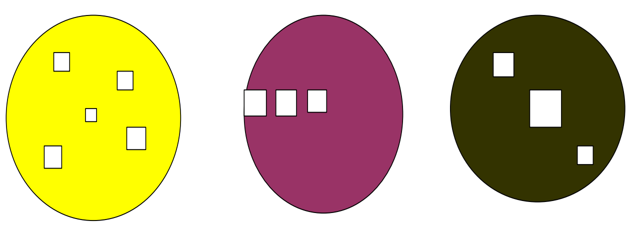
Figure 1 Principle of ACO

The assumption is taken that right one is shortest path the pheromone will accumulate at shortest path at as such ants will follow the location with shortest path as shown in Fig (a). The behavior will provide road map for optimization schemes.

The Ant Colony Systems works on the principle of applying minimum cost function analysis. The optimization problems that involve best possible goal will be inspired by ant colony optimization scheme.

3. PARTICLE SWARM OPTIMISATION (PSO)

The particle swarm optimization works on the principle swarm intelligence involving following homogeneity, Locality, Collision avoidance, Velocity matching and Flock centering. The concept involves particles placed in research space that consistently evaluates objective function. The particle take decision on movement based on own current fitness and best location with other members. The net outcome is swarm movement like that of bird flocking [5]. The global minimum and local minimum problems as such is addressed as flock of birds in unison search for food and in technical terms closely follow optimum function which is also called fitness function. Each solution is considered as bird, called particle All the particles have a fitness value. The fitness values can be calculated using objective function All the particles preserve their individual best performance They also know the best performance of their group They adjust their velocity considering their best performance and also considering the best performance of the best particle.



(A) (B) (c)

Figure 2 (A) Separation (B) Alignment (C) Cohesion Craig Reynolds describe the process in simple behavior in the form of Separation, Alignment and Cohesion.

The avoidance of crowding, heading toward local folk-mates and moving toward average position.

Each particle keeps track:

a)Its optimal solution, personal best, par_{best}

b)The optimized value of any particle, global best, $glob_{best}$

The word derives its energy from population and swarming. The dimensional space is taken as problem in which researchers opt for optimized solutions. The number of parameters to be optimized is taken in a set the coordinates designated by x and y, each particle occupies position Xvd and travel with velocity Vvd, $1 \leq v \leq s$ and $1 \leq d \leq n$. The word how fit the particle is determined by search of best value in local and global domain. The memory system determine the storage of pbestid each particle and the position where highest fitness in the form of $glob_{best}$ is taken is optimized solution in optimization scheme. The iteration values is taken as kk velocity vvd and position Xvd of each particle are updated using (1) and (2).

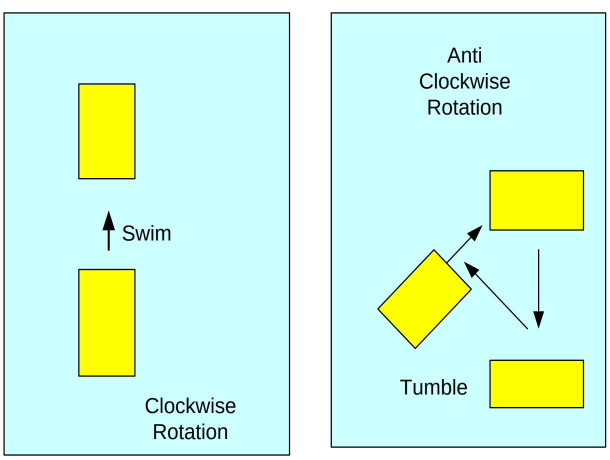
$$vvd(kk + 1) = w \cdot vvd(kk) + c1 \cdot random1 \cdot (par_{best}vd - Xvd) + c2 \cdot random2 \cdot (glob_{best}d - Xvd) \quad (1)$$

$$Xvd(kk+1) = Xvd(kk) + vvd(kk+1) \quad (2)$$

Here, The range of random numbers random1 and random2if uniform distribution in between 0 and 1.

4. BACTERIAL FORAGING OTIMIZATION (BFO)

Natural selection tends to eliminate animals with poor foraging strategies such as locating, handling and ingesting food and favor the propagation of genes of those to achieve successful foraging [6-13]. Basing on this search and obtaining nutrients in animals is to maximize the ratio of E/T where E is the energy obtained and T is the time spent for acquiring of nutrition. The foraging behavior of E.Coli is used for evolutionary computation algorithm. E.Coli is a bacteria, existent in gut, having of diameter of 1µm and length parameter of 2µm. The efficacy of reproduction is at 10^{-7} by means of splitting within a time span 20 minutes rate. The E-Coli bacteria has flagella which provide it ability to move up 100-200 rps by means of flagella. It alternates between running at the speed of 10-20 µm/sec and tumbling. When the flagella rotate clockwise they may run or tumble and switching in between of these two operations during its entire lifetime. Bacterial Foraging is an evolutionary optimization technique which is phenomenon of global search on the methodology of population search. The preparation of algorithm is on biological movement of the E.Coli bacteria by virtue of chemo-taxis, swarming, tumbling, reproduction, elimination and dispersal which serve as various stages in development and implementation of optimization process. In chemo taxis, the left-handed helix flagellum is a tuned so that, flagellum base rotates anti-clockwise, thereby producing inertia against the bacterium, which will force the cell. If not so, flagellum operates will be independent relative of the others and rotate the clockwise rotation will be source of tumbling of E.Coli. The process reproduction, health parameters will be taken care off the offspring will be best solution such that the lowest healthy E.Coli die and the healthy E.Coli splits into two, the locational aspect will be same. This causes the population of bacteria remain constant. The process elimination with dispersal of events truly form the basis on mobility of population to long-distance called as foraging behaviorism. They assisting during chemo-tactic progress by placement of bacteria to the nearest required values. The direction of optimization will be in the right direction, then the swarming took place, causing increase in running speed terminology will be running speed increases. The other option will be tumbling to proceed to right direction that will be right optimization. The modelling will be base for optimization models and its validity will hold for foraging. Foraging can be modeled as an optimization process where an animal seeks to maximize the energy obtained per unit time spent foraging. To begin by over viewing the relevant research in foraging theory, foraging communicating organisms (social foraging) which sometimes operate in swarms, and in relevance of these areas to optimization [4-9]. The view that social foraging evolved for improving climbing of noisy gradients of nutrient resources is introduced. Ant colony optimization [9] is an optimization method based on foraging in ant colonies. The, the focus is on biomimicry for solution of optimization algorithms (e.g., of Bacterial foraging is a concept that has been recently discovered by K.M.Passino in year 2002[1]. The technique is based on foraging (search for food). Bacteria search for food in such a way that the maximum energy is preserved [1]. Movement of bacteria consumes energy; so it moves in best-optimized path to gain more energy than it loses. The optimized path that is being used by bacteria forms the basis for new optimization algorithm i.e. Bacteria foraging technique, which can be used in optimizing many Engineering problems. In this paper, this optimization scheme is used in Microstrip antenna design for feed point determination.



(A) (B)

Figure 3 (A) Swim (B) Tumble

5. MERITS AND DEMERITS

(A)Advantages of the Ant Colony Optimization

The ant parallelism with mechanism of feedback Efficient for Traveling Salesman Problem and similar problems can be used in dynamic applications (adapts to changes such as new distances, etc.)[14]

(B)Disadvantages of the Ant Colony Optimization

Difficulty in theoretical analysis and randomization of decisions, the probability distribution make it complicated. The convergence is uncertain [14].

(C)Advantages of Particle Swarm Optimization

It is based on intelligence and practical oriented for applications. The convergence times is fast. The adaptation of scheme is fast [14]

(D)Disadvantages of Particle Swarm Optimization

It suffers from the partial optimism, which causes the less exact at the regulation of its speed [14]

(E)Advantages of the Bacterial Foraging Algorithm

Its simplicity and application oriented approach make this as lucrative option. It is widely accepted as globally optimization tool

(F)Disadvantages of Bacterial Foraging Algorithm

BFO possesses a poor convergence behavior over complex optimization problems as compared to other nature-inspired optimization techniques [15-20]

6. BACTERIAL FORAGING AND ITS IMPLEMENTATION

The search is capable of locating feed point. Bacterial foraging is used to calculate the feed point of coaxial fed

$$\mathbf{Z_{in}(y = y_o) = Z(y = 0).Cos^2}\left(\pi \frac{\mathbf{y_o}}{\mathbf{L}}\right) \quad (3)$$

Microstrip rectangular patch antenna. The equation presented in ref [15-20] is used as cost function. Considering the Microstrip patch antenna.

Length = 0.906 cm, Width=1.186cm, Height = 0.1588cm, Dielectric constant =2.2 and operating at 10 GHZ, we use Bacterial foraging with the above cost function to find 50 ohm feed location. Fig 4 shows the results. The location for y_o found from BFA method is 0.3037. When compared with published results [10] it seems the error is 3.07 %.It seems Bacterial foraging algorithm can be suitably used for calculating feed point of miniaturized planar antenna

OUTPUTS FROM PROGRAM

J(:,:,1,1) =

0.3027	0.3027
0.3027	0.3027

J(:,:,2,1) =

0.3027 0.3027
0.3027 0.3027

J(:,:,3,1) =

0.3027 0.3027

0.3027 0.3027

J(:,:,4,1) =

0.3027 0.3027

0.3027 0.3027

J(:,:,5,1) =

0.3027 0.3027
0.3027 0.3027

J(:,:,6,1) =

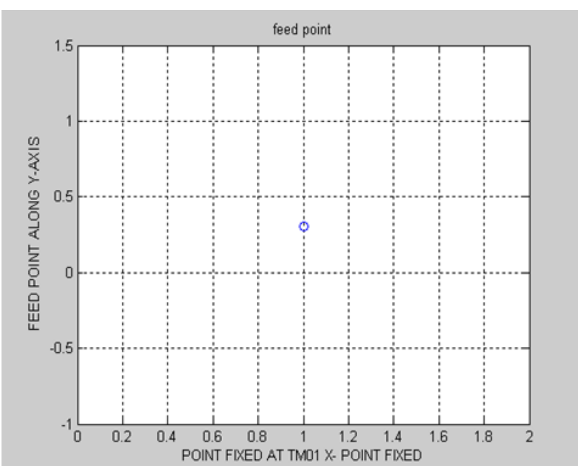
0.3027 0.3027
0.3027 0.3027

J(:,:,7,1) =

0.3027 0.3027
0.3027 0.3027

The optimized value for the feed point is found to be:

Jlast = 0.3027



The optimized value for the feed point is found to be:

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7. CONCLUSION

The paper bring into light various natural evolutionary optimization schemes with practical implementation on design and characterization of microstrip patch antenna. The attainment of feed point using bacterial foraging scheme is a testimony application oriented approach of evolutionary schemes. The future approach will be involvement of various hybrid approaches to decrease number of iterations required to achieve best possible goal.

REFRENCES

[1] Angeline, P. “Evolutionary optimization versus particle swarm optimization: Philosophy and performance differences". Proceedings of evolutionary programming, Berlin: Springer. 1998, pp. 601–610.

[2] Y. Liu and K. M Passino, Biomimicry of social foraging bacteria for Distributed Optimization: models, principles, and emergent behavior, Journal of optimization theory and applications, Vol.115, No. 3, December 2002, pp. 603–628.

[3] E.Corchado, PSO and ACO in Optimization Problems, Publishers: Springer - Verlag, 2006, pp. 1390 – 1398.

[4] Macro Dorigo, The Ant System: Optimization by a colony of cooperating agents.

[5] P.Mathiyalagan, Grid scheduling Using Enhanced PSO Algorithm International Journal on Computer Science and Engineering, Vol. 02,No. 02, 2010, 140-145

[6] Eric.L.Charnov and Gordon.H.Orains, Optimal foraging some theoretical explorations, (University of Washington, 1973).

[7] Crina Grosan and Ajith Abraham, “Stigmergic optimization: inspiration technologies and perspectives” Department of Computer Science Babes¸-Bolyai University, Cluj Napoca, 3400, Romania 2IITA Professorship Program, School of Computer Science and Engineering Chung-Ang University, Seoul, Korea),pp. 156-756

[8] Ajith Abraham,Swagatam Das,Sandip Roy, “Swarm Intelligence Algorithms for Data Cluctering” January 2008.

[9] E.Corchado, PSO and ACO in Optimization Problems, Publishers: Springer - Verlag, 2006 pp. 1390 – 1398.

[10] Y. Liu and K. M Passino, “Biomimicry of social foraging bacteria for Distributed Optimization: models, principles, and emergent behavior” Journal of optimization theory and applications, Vol.115, No. 3, December 2002, pp. 603–628.

[11] Eric.L.Charnov and Gordon.H.Orains, Optimal foraging some theoretical explorations, University of Washington, 1973.

[12] Veysel Gazi and Kevin M. Passino, “Stability analysis of social foraging swarms” IEEE transactions on systems, man, and cybernetics— part b: cybernetics, vol. 34, no. 1, February, 2004, pp. -539-557.

[13] V.Selvi and R. Umarani, “Comparative Analysis of Ant Colony and Particle Swarm Optimization Techniques” International Journal of Computer Applications (0975 – 8887) Volume 5– No.4, August 2010.

[14] S.Mishra, “Hybrid least-square adaptive bacterial foraging strategy for harmonic estimation” IEEE Proc.-Gener.Transm. Distribution, Vol. 152, No. 3, May 2005, pp. 379 – 389.

[15] S. Mishra Hybrid least square-fuzzy bacterial foraging strategy for harmonic estimation, IEEE transactions on evolutionary computation,vol. 9, no. 1, February 2005, pp.: 61 –73.

[16] S. Mishra, B, K, Panigrahi, M. Tripathy, A hybrid adaptive-bacterial-foraging and feedback linearization scheme based d-statcom, International Conference on Power System Technology Volume 1, Issue, 21-24 Nov.2004, Vol.1, pp. 275-280.

[17] Kevin M. Passino, “Distributed optimization and control using only a germ of intelligence” Proceedings of the IEEE International Symposium on Intelligent Control Volume, Issue, 2000, pp. P5- 13.

[18] Vitorino Ramos, Carlos Fernandes, Agostinho C. Rosa, “Social cognitive maps, swarm collective perception and distributed search on dynamic landscapes” Journal of New Media in Neural and Cognitive Science, NRW, Germany, for his inaugural issue. March 2005.

[19] S.S.Pattnaik, Dhruba. C.Panda and S.Devi, “Input impedence of rectangular microstrip patch antenna using artificial neural networks” Microwave and Optical technology letters/vol-32, No.5, March 5, 2002, pp.381-383.

[20] M. D. Deshpande, M.C. Bailey, “Input impedence of microstrip antennas”,Antennas and Propagation, IEEE Transactions on [legacy, pre - 1988] Volume 30, Issue4, Jul 1982, pp. 645-650.