SURVEY ON IMPROVED ARTIFICIAL BEE COLONY ALGORITHM FOR BALANCING EXPLORATION AND EXPLOITATION

K.Deepa Thilak

Research Scholar,Computer Science and Engineering,
Pondicherry Engineering College
Puducherry, India.
Email-Id: kdeepafeb@pec.edu

A.Amuthan

Professor,Computer Science and Engineering,
Pondicherry Engineering College
Puducherry, India.
Email-Id: amuthan@pec.edu

Abstract: Today many fields like engineering, management, and economy faces many optimization problems which are needed to be solved by meta-heuristics techniques. The Artificial Bee Colony (ABC) algorithm is a population-based stochastic swarm intelligence algorithm finds applications in most of the fields. The problem with ABC is its slow convergence speed due to the poor exploitation capability and falls into local minima in the case of multimodal functions. The efficiency of the standard ABC lies in the balance between the exploration and exploitation level since ABC is good at exploration. Researchers are working on ABC by applying new techniques in each phase to increase the capability of the algorithm. Many improved ABC algorithms are proposed, mostly the improvement is found in onlooker or scout bee phase, in the literature each with a novel, hybrid techniques to increase the performance of the algorithm. This paper explores the work carried out in the literature to provide the good knowledge of improving the algorithm to attain the best search results.

Keywords*: Swarm Intelligence, Meta-Heuristics, Artificial bee Colony Optimization, Exploration and Exploitation.*

I. INTRODUCTION

The optimization problems are mostly solved by various meta-heuristics algorithms to achieve the nearest feasible solution with large candidate solution and partial information. Swarm Intelligence [6-9] came played a key role in solving these complex problems using the dynamic random behaviour of the natural creatures. Mostly the food searching process (behaviour) of the fishes, ants, honey bees and frogs are adopted to discover the solutions for NP-hard problems. By using the foraging behaviour of these species researchers have proposed the artificial algorithms to search in a large area, to name a few Swarm Optimization from fish [10], Ant Colony Optimization from ant behaviour [11], Particle Swarm Optimization from flock of birds [12], Fish Firefly Algorithm from firefly behaviour[13], Frog Leaping Optimization from frog [14], etc. All these algorithms are population-based stochastic nature algorithms shows good search abilities to solve many unsolvable problems.

Artificial Bee Colony algorithm is a population- based stochastic algorithm which makes use of the food searching behaviour of the honey bees [15] is proposed by Karaboga in 2005. Through the social behaviour of the swarm of bees, many optimization problems are solved. Even though with many advantages it was found that ABC suffers from the drawback of slow convergence speed [16] because of the special search pattern which keeps on searching around the previous best solution.

Still, the research gap is found in keeping the balance between the exploration and exploitation tendency of the ABC algorithm. This paper reviews the works carried out in improving the global searching capability in terms of exploration and exploitation. The following section gives the basic concepts involved in standard ABC algorithm along with flow diagram and algorithm. Section 3 highlights the techniques to improve the algorithm with the conclusion in section 4.

II. BASIC CONCEPT

The honey bees follow the social behaviour for searching food around them. The scout bee finds the place of food source and the follower bees follow a scout bee based on the dance they perform on dance area until food is available they follow the same path. The food searching behaviour is adopted as Artificial Bee Colony algorithm to solve many optimization problems in different domains.

2.1 Artificial Bee Colony Algorithm

In ABC system, initially bees fly randomly around in a multidimensional search space to find the food source and once they find food sources, they perform wangle dance in the dance area to intimate other bees. By seeing the dance the employee bees follow the food source found by scout bees. The onlooker bees select the best employee bee whose food source has high nectar amount. As the iteration goes the food source is exploited by the employee bee phase, once the nectar gets over the employee bee becomes unemployed bee(scout bee).Again the scout bee explores to find the new food source, this process is repeated for given number of times. Thus, ABC system achieves local optimization using employee and onlooker bees and global optimization with onlooker and scout bee phase to have a good balance between exploration and exploitation.

It is as similar to Particle Swarm Optimization (PSO) and Differential Evolution (DE) algorithms use control parameters and objective function to measure the performance.ABC being an optimization technique provides a population-based stochastic search procedure in which food locations are modified by the artificial bees with time and the bees discover the places of food with huge nectar amount and finally come with the one with more nectar.

2.2 Phases of ABC

The artificial bee algorithm makes use of three kinds of bees: employee bees, onlooker bees and scout bees that are classified as employed bees and unemployed bees. The actual work in finding the food source is carried out by employee bees which are ca come under employed bees and other two classified under the unclassified category. Based on these classes ABC has three phases each with different functions in finding food source with good nectar amount.

1. Scout Bee Phase:

Scout bees are responsible for finding new find source where a huge amount of nectar is present. They help in exploration process of ABC algorithm to achieve global optimization to the given problem.

2. Employee Bee Phase:

The employee bee follows the scout bee to update the nectar amount in the food source for each travel, and perform wangle dance in dance area to reflect their efficiency of the solution (amount of nectar). The employee bee phase along with onlooker supports for local optimization (i.e.) exploitation of the found solution.

3. Onlooker Bee Phase:

The onlooker bees choose the best food source based on the dance performed by employed bees.

The number of employee bees and onlooker bees is equal to the number of food sources. In ABC algorithm the position of the food source is the feasible solution to the optimization problem and the quality of the food source is based on the fitness function, evaluated by application constraint. The size of the population designated is the sum of the number of employed bees.

2.3 Flow Diagram

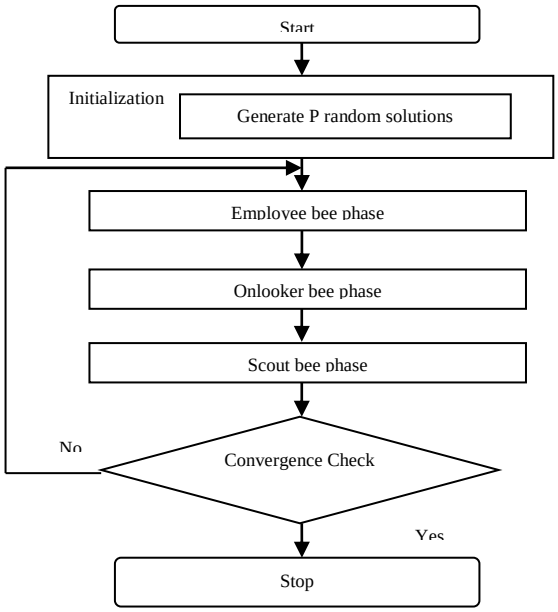

Figure 1. Flow diagram for standard ABC algorithm

2.4 Algorithm

Initialization Phase
All the vectors of the population of food sources, xm→'s, are initialized (m=1...SN , SN: population size) by scout bees and control parameters are set.The following definition might be used for initialization purposes (1):

$$x_{mi} = l_i + rand(0,1) * (u_i - l_i) \quad (1)$$

where li and ui are the lower and upper bound of the parameter xmi , respectively.
Repeat
Employed Bees Phase
Determine the neighbor food source υm→ using the formula given by equation (2):

$$v_{mi} = x_{mi} + \varphi_{mi} (x_{mi} - x_{ki}) \quad (2)$$

where xk→ is a randomly selected food source,
i is a randomly chosen parameter index and
ϕmi is a random number within the range [−a,a] .
After producing the new food source υm→ , its fitness is calculated and a greedy selection is applied between υm→ and xm→ .
The fitness value of the solution, fitm(xm→) , might be calculated for minimization problems using the following formula (3)

$$fit_m(\vec{x}_m) = \begin{cases} \frac{1}{1+f_m(\vec{x}_m)} & if\ f_m(\vec{x}_m) \geq 0 \\ 1 + abs(f_m(\vec{x}_m)) & if\ f_m(\vec{x}_m) < 0 \end{cases} \quad (3)$$

where fm(xm→) is the objective function value of solution xm→ .
Onlooker Bees Phase
Choose a food source depending on the probability values calculated using the fitness values provided by employed bees. For this purpose, a fitness based selection technique can be used, such as the roulettewheel selection method. The probability value pm with which xm→ is chosen by an onlooker bee can be calculated by using the expression given in equation (4):

$$p_m = \frac{fit_m(\vec{x}_m)}{\sum_{m=1}^{SN} fit_m(\vec{x}_m)} \quad (4)$$

Scout Bees Phase
Search new solution by by equation (1).
Memorize the best solution achieved so far
Until (Cycle=Maximum Cycle Number)

III. Survey on Improved Artificial Bee Colony Algorithms.

The authors in [1] proposed an improved ABC algorithm to improve exploration performance by introducing the Rate of Change (RoC) concept using the slope to modify the limit in the scout bee phase to improve the exploration. The RoC in the performance graph is tested over benchmark functions and colony size parameter and produced good improvement in the algorithm exploration. The ABC algorithm performance degrades because they are poor at exploitation [5] which is handled in [2] by modifying the onlooker bee phase to concentrate the search based on previous best solution and scout phase by computing the distance between the best and worst solution so that to avoid generating worst solutions.

The exploitation of the solution from a search area is improved in [3] by using Grenade explosion in onlooker bee phase where the searching depth is increased. To balance the exploitation with the exploration the authors applied Cauchy operator in scout bee phase. The experiment results proved that performance increased by applying the modifications. In [4] the exploitation is improved by applying Differential Evolution (DE) in the onlooker bee phase and the employee bee phase equation is improved to balance the exploration. Other techniques [5] applied the meta-heuristic Simulated Annealing to improve exploration and self-adaptive perturbation rate to have good exploitation.

The optimal route for data delivery in VANET [6] is achieved by adopting ABC algorithm for sending data packets using clustering. The author uses two types of packets, scout packet to discover route and forager to forward data. In [7] efficient and reliable communication is achieved by using multicast routing. The routing problem is transformed to SM, micro-population considered and variation in the formula for each phase based on QoS parameters.

The drawback of standard ABC is slow convergence which is handled by [8] modifying the initializing phase to generate random solutions and the search equation of the scout bee phase is modified by applying mutation operator. Also in [9], the authors proposed new phases in ABC algorithm before employee phase to select the best local solution. The search equation of the onlooker and employee bee phase is modified to have good global optimal solution and convergence.

The initial population plays a major role in the convergence of the algorithm, so the authors in [10] focused on initialization phase. The initial population selection, if made random, achieves good convergence is the motive of the proposed work. The randomness is achieved by applying by opposition-based learning and chaotic systems. The mutation operator of DE is used in the search equation to have good exploration. The Same technique is followed in [11] using DE/best/1 version of mutation operator along with the parameter tuning to reduce computation time and enhance convergence speed. In [12] the initial population is arranged in an orthogonal array for a better scattering of feasible solutions and new search rule is introduced with DE/rand/2 and De/best/2 to enhance exploration and convergence respectively. In [15] initial population is improved by chaotic systems and opposition based learning and Search equation is modified using DE/rand/1 and DE/best/2 along with tuning the probability parameter.

The balance between the level of exploration and exploitation must be maintained to have a better solution, [13] focus on Cognitive learning factor in onlooker bee and employed bee phase and the control parameter, limit and target food number to balance the exploitation and exploration level of the standard ABC algorithm. [14] Proposed two algorithms I-ABC and PS-ABC by modifying the search process in onlooker and employed bee phase to increase the efficiency of the ABC algorithm. Through test results, the authors found that by improving the bee phases the efficiency can be improved. In [16] chaotic systems and opposition based learning applied for initialization process and adaptive tent chaotic maps along with tournament selection are introduced for searching. In [17] ABC is applied in image processing to cluster two binary vectors based on the similarity measure and select the difference between the best and worst vectors to avoid generating poor solutions.

3.1 ABC in Power Engineering

Transmission power loss has become the big issue in distributing electricity supply to the participants due to the deregulation market to manage the power distribution. This issue was addressed by many researchers to properly allocate the power loss to the intended participants. The Artificial bee colony meta-heuristics approach is applied in [36] to solve power loss allocation by determining fair, transparent and equitable charges among the participants.

The Optimal Power Flow problem (OPF) is an optimization problem handled by artificial bee colony algorithm in [37] to give a feasible solution in a quick manner. The objective of OPF is to minimize power generation cost with the constraints of capacity limits; line flow limits bus voltage limits. Similarly in [38] for Reactive Power Optimization, artificial bee colony algorithm is applied to have a secure and economic run of power systems. The authors focused on three objective functions active power loss, voltage profile of buses and cost function of reactive power sources to find the near solution.

To reconfigure the distribution feeder in different branches with distributed generation is an optimization problem. In [39] the authors used the benefits of artificial bee colony algorithm to find the best place for DG placement and good reconfiguration of the network. They used loss sensitivity index as an objective function to find the place and DG placement location.

Table1: Summary of Artificial Bee Colony Algorithm with improved rules

S.No	Author/Year	Title	Technique
1.	Anuar, Syahid, Ali Selamat, and Roselina Sallehuddin/2016/ *Journal of King Saud University-Computer and Information Sciences*	A modified scout bee for artificial bee colony algorithm and its performance on optimization problems	The rate of change is applied to modify limit in scout bee phase to improve exploration performance.
2.	Liquan, Zhao, Wang Xin, and Wang Lin, *Control Science and Systems Engineering (ICCSSE)-IEEE International conference/2016*	A novel artificial bee colony algorithm for numerical function optimization	The search equations are modified to enhance performance. In Onlookers Bee phase- previous best solution is used. In Scout Bee phase- distance between the optimal and worst solution is used.
3.	Zheng, Jian-Guo, Chao-Qun Zhang, and Yong-Quan Zhou/2015/Mathematical Problems in Engineering(Hindawi)	Artificial Bee Colony Algorithm Combined with Grenade Explosion Method and Cauchy Operator for Global Optimization	To enhance exploitation and convergence speed Grenade explosion method used in onlooker bee phase. To escape from local optima problem and enhance exploration Cauchy Operator used in scout bee phase.
4.	Zhang, Song, and Sanyang Liu/2015/ Mathematical Problems in Engineering(Hindawi)	A novel artificial bee colony algorithm for function optimization	In onlooker bee phase-Differential evolution is applied to enhance exploitation and improve employee bee phase to improve exploitation.
5.	Alam, Mohammad Shafiul, Md Monirul Islam, and Kazuyuki Murase/2012/Springer International Conference.	Artificial bee colony algorithm with improved explorations for numerical function optimization	Simulated Annealing (SA) based probabilistic selection-to improve exploration. Self-adaptive perturbation rate-to improves exploitation.

6.	Bansal, Jagdish Chand, et al/2013/ *International Journal of Artificial Intelligence and Soft Computing*	CBQoS-Vanet: Cluster-based Artificial Bee Colony Algorithm for QoS Routing Protocol in VANET	Optimal route is selected from cluster head to the destination by considering the QoS parameters like bandwidth availability, end-to-end delay, etc. Uses two types of packet, 1. Scout – discover route 2. Forager- forward data.
7.	Li, Guoqiang, Peifeng Niu, and Xingjun Xiao/2016 *Applied soft computing*	A micro-artificial bee colony based multicast routing in vehicular ad Hoc networks	Efficient and reliable communication is achieved by using multicast routing. The routing problem is transformed to SM, micro-population considered and variation in formula for each phase based on QoS parameters.
8.	Ait Sahed, Oussama, et al/2016/ *International Journal of General Systems*.	An efficient artificial bee colony algorithm with application to nonlinear predictive control	The standard ABC algorithm is improved in convergence by modifying the initializing phase, search equation (applying mutation –DE)and limit factor of scout bee.
9.	Sulaiman, Noorazliza, Junita Mohamad-Saleh, and Abdul Ghani Abro/2015/ *The Scientific World Journal*	New enhanced Artificial Bee Colony (JA-ABC5) algorithm with application for reactive power optimization	To enhance convergence speed and to reach global optimum following modifications are performed 1. New phase between initialization and employee bee phase 2.Modified Mutation equation is applied in onlooker and employee bee phase
10	Gao, Wei-feng, and San-yang Liu/2012/ *Computers & Operations Research*	A modified artificial bee colony algorithm	Employs opposition-based learning method and chaotic systems to generate initial population to have better balance and introduces DE to have better convergence.
11	Y. Xu, P. Fan, and L. Yuan/2013/Mathematical Problems in Engineering.	A simple and efficient artificial bee colony algorithm	The ABC algorithm is combined with DE/best/1 optimization technique along with a parameter tuning to reduce the computation time and enhance convergence speed.
12	Kong, Xiangyu, Sanyang Liu, and Zhen Wang/2013/ *International Journal of Signal Processing, Image Processing and Pattern Recognition*.	An improved artificial Bee Colony algorithm and its application	The initial population is arranged in an orthogonal array for better scattering of feasible solutions and new search rule is introduced with DE/rand/2 and De/best/2 to enhance exploration and convergence respectively.
13	Bansal, Jagdish Chand, et al/2013/ *International Journal of Artificial Intelligence and Soft Computing.*	Balanced artificial bee colony algorithm	Cognitive learning factor in onlooker bee and employed bee phase and control parameter like limit and target food number to balance the exploitation and exploration.
14	Li, Guoqiang, Peifeng Niu, and Xingjun	Development and investigation of	Proposed two algorithms I-ABC and PS-ABC by modifying the

	Xiao/2012/ *Applied soft computing*	efficient artificial bee colony algorithm for numerical function optimization	search process in onlooker and employed bee phase.
15	Gao, Weifeng, and Sanyang Liu/2011/ *Information Processing Letters* (Elsevier).	Improved artificial bee colony algorithm for global optimization	Initial population by chaotic systems and opposition based learning and Search equation modified using DE/rand/1 and DE/best/2 along with tuning the probability parameter.
16	Kuang, Fangjun, et a/2014/*2014 IEEE Congress on Evolutionary Computation.*	A novel chaotic artificial bee colony algorithm based on tent map	Initial population by chaotic systems and opposition based learning and self –adaptive tent chaos search is applied along with tournament selection.
17	Ozturk, Celal, Emrah Hancer, and Dervis Karaboga/2015/ *Applied Soft Computing*	Dynamic clustering with improved binary artificial bee colony algorithm	Clustering the binary vectors based on similarity measure and applying the cross over operation.
18	Minhat, A. R., et al., *Power Engineering and Optimization Conference (PEOCO), 2014 IEEE 8th International*. IEEE, 2014.	Implementation of Artificial Bees Colony algorithm on real power line loss allocation	ABC is used to solve power line loss problem to have a fair allocation of loss.
19	Le Dinh, Luong, Dieu Vo Ngoc, and Pandian Vasant. , *The Scientific World Journal* 2013 (2013).	Artificial bee colony algorithm for solving optimal power flow problem	OPF problem is handled by ABC to handle power generation with low cost with constraint resources.
20	Ozturk, Ali, et al., *Scientific Research and Essays* 5.19 (2010): 2848-2857.	Reactive power optimization with artificial bee colony algorithm	Multi-objective Reactive power optimization is done by applying ABC algorithm for secure and economic user of power sources.
21	Murthy, GV K., S. Satyanarayana, and B. Hanumantha Rao. (2012).	Artificial bee colony algorithm for distribution feeder reconfiguration with distributed generation	Find the optimal location for placing DG in the network.

III. CONCLUSION

The algorithm whose execution time is not in polynomial time and no prediction of the algorithms is available (NP-hard problems) can go for a meta-heuristics algorithm for getting the feasible solution. ABC is a swarm intelligence meta-heuristic algorithm is one of the simple and efficient algorithms to solve NP-hard problems and is found in many applications like TSP, Vehicular Routing Problem, and Mobile Routing and almost in all the fields. Much research work has been carried out in exploring the capability of ABC in finding the best optimal solution for the given problem and found that the standard ABC algorithm suffers from slow convergence problem, local optimum problem, and more computational time. In literature many improved ABC are available to overcome these drawbacks in terms of modifying the search equation in employed bee phase, search equation of onlooker bee phase and Scout bee phase. This paper gives the general survey of the different works carried to improve the performance of ABC with the summarization of all the works. The paper also gives the works carried out by ABC algorithm with power engineering field to optimize different issues related to them.

REFERENCES

[1] Anuar, Syahid, Ali Selamat, and Roselina Sallehuddin. "A modified scout bee for artificial bee colony algorithm and its performance on optimization problems." *Journal of King Saud University-Computer and Information Sciences*, 2016.

[2] Liquan, Zhao, Wang Xin, and Wang Lin. "A novel artificial bee colony algorithm for numerical function optimization." *Control Science and Systems Engineering (ICCSSE), 2016 2nd International Conference on*. IEEE, 2016.

[3] Zheng, Jian-Guo, Chao-Qun Zhang, and Yong-Quan Zhou. "Artificial Bee Colony Algorithm Combined with Grenade Explosion Method and Cauchy Operator for Global Optimization." *Mathematical Problems in Engineering* 2015.

[4] Zhang, Song, and Sanyang Liu. "A novel artificial bee colony algorithm for function optimization" *Mathematical Problems in Engineering* 2015, 2015.

[5] Alam, Mohammad Shafiul, Md Monirul Islam, and Kazuyuki Murase. "Artificial bee colony algorithm with improved explorations for numerical function optimization." *International Conference on Intelligent Data Engineering and Automated Learning*. Springer Berlin Heidelberg, 2012.

[6] X. S. Yan.: Efficiency analysis of swarm intelligence and randomization techniques. Journal of Computational and Theoretical Nanoscience, vol. 9, no. 2, pp. 189-198, 2012.

[7] W. Deng, R. Chen, J. Gao, Y. J. Song and J. J. Xu. : A novel parallel hybrid intelligence optimization algorithm for a function approximation problem. Computers and Mathematics with Applications, vol. 63, no. 1, pp. 325-336, 2012.

[8] S. Z. Zhang, C. K. M. Lee, H. K. Chan, K. L. Choy and Z. Wu.: Swarm intelligence applied in green Logistics: A literature review. Engineering Applications of Artificial Intelligence, vol. 37,pp. 154-169, 2015.

[9] M. Kumar, A. Sharma and R. Kumar.:Optimization of test cases using soft computing techniques: A critical review.WSEAS Transactions on Information Science and Applications, vol. 8, no. 11, pp. 440-452, 2011.

[10] Gao, Yanbin, et al. "A Novel Artificial Fish Swarm Algorithm for Recalibration of Fiber Optic Gyroscope Error Parameters." *Sensors* 15, 10547-10568, 2015.

[11] Bianchi, Leonora, Marco Dorigo, Luca Maria Gambardella, Walter J. Gutjahr.: A survey on metaheuristics for stochastic combinatorial optimization. *Natural Computing: an international journal*. 8 (2), 239–287, (2009)

[12] J. Kennedy and R. Eberhart, "Particle swarm optimization," in Proceedings of the IEEE International Conference on Neural Networks, pp. 1942–1948, December 1995.

[13] X. S. Yang, "Firefly algorithm, stochastic test functions and design optimization," International Journal of Bio-Inspired Computing, vol. 2, no. 2, pp. 78–84, 2010.

[14] Pourmahmood, Mohammad, Mohammd Esmaeel Akbari, and Amin Mohammadpour. "An efficient modified shuffled frog leaping optimization algorithm." *Int. J. Comput. Appl* 32.1, 0975-8887, 2011.

[15] D. Karaboga, "An idea based on honey bee swarm for numerical optimization," Tech. Rep. TR06, Erciyes University, Engineering Faculty, Computer Engineering Department, 2005.

[16] W. F. Gao and S. Y. Liu, "A modified artificial bee colony algorithm," Computers and Operations Research, vol. 39, no. 3, pp. 687–697, 2012.

[17] Fekair, Mohammed El Amine, Abderrahmane Lakas, and Ahmed Korichi. "CBQoS-Vanet: Cluster-based artificial bee colony algorithm for QoS routing protocol in VANET." *Selected Topics in Mobile & Wireless Networking (MoWNeT), 2016 International Conference on*. IEEE, 2016.

[18] Zhang, Xiu, Xin Zhang, and Cheng Gu. "A micro-artificial bee colony based multicast routing in vehicular ad hoc networks." *Ad Hoc Networks*, (2016.

[20] Ait Sahed, Oussama, et al. "An efficient artificial bee colony algorithm with application to nonlinear predictive control." *International Journal of General Systems* 45.4, 393-417, 2016.

[21] Sulaiman, Noorazliza, Junita Mohamad-Saleh, and Abdul Ghani Abro. "New enhanced Artificial Bee Colony (JA-ABC5) algorithm with application for reactive power optimization." *The Scientific World Journal* 2015, 2015.

[23] Karaboga, Dervis, et al. "A comprehensive survey: artificial bee colony (ABC) algorithm and applications." *Artificial Intelligence Review* 42.1, 21-57, 2014.

[24] Gao, Wei-feng, and San-yang Liu. "A modified artificial bee colony algorithm." *Computers & Operations Research* 39.3, 687-697, 2012.

[25] Kumar, Sandeep, Vivek Kumar Sharma, and Rajani Kumari. "An Improved Memetic Search in Artificial Bee Colony Algorithm." *International Journal of Computer Science and Information Technology (0975–9646)* 5.2, 1237-1247, 2014.

[26] Y. Xu, P. Fan, and L. Yuan, "A simple and efficient artificial bee colony algorithm," Mathematical Problems in Engineering, vol. 2013, Article ID 526315, 9 pages, 2013.

[27] Kong, Xiangyu, Sanyang Liu, and Zhen Wang. "An improved artificial Bee Colony algorithm and its application." *International Journal of Signal Processing, Image Processing and Pattern Recognition* 6.6, 259-274, 2013.

[28] Bansal, Jagdish Chand, et al. "Balanced artificial bee colony algorithm." *International Journal of Artificial Intelligence and Soft Computing* 3.3, 222-243,2013.

[29] Li, Guoqiang, Peifeng Niu, and Xingjun Xiao. "Development and investigation of efficient artificial bee colony algorithm for numerical function optimization." *Applied soft computing* 12.1, 320-332, 2012.

[30] Gao, Weifeng, and Sanyang Liu. "Improved artificial bee colony algorithm for global optimization." *Information Processing Letters* 111.17, 871-882, 2011.

[31] Karaboga, Dervis, and Bahriye Akay. "A comparative study of artificial bee colony algorithm." *Applied mathematics and computation* 214.1, 108-132, 2009.

[32] Bansal, Jagdish Chand, Harish Sharma, and Shimpi Singh Jadon. "Artificial bee colony algorithm: a survey." *International Journal of Advanced Intelligence Paradigms* 5.1-2, 123-159, 2013.

[33] Kuang, Fangjun, et al. "A novel chaotic artificial bee colony algorithm based on tent map." *2014 IEEE Congress on Evolutionary Computation (CEC)*. IEEE, 2014.

[34] Ozturk, Celal, Emrah Hancer, and Dervis Karaboga. "Dynamic clustering with improved binary artificial bee colony algorithm." *Applied Soft Computing* 28, 69-80, 2015.

[35] Milan, T. U. B. A. "Artificial Bee Colony (ABC) Algorithm Exploitation and Exploration Balance."

[36] Minhat, A. R., et al. "Implementation of Artificial Bees Colony algorithm on real power line loss allocation." *Power Engineering and Optimization Conference (PEOCO), 2014 IEEE 8th International*. IEEE, 2014.

[37] Le Dinh, Luong, Dieu Vo Ngoc, and Pandian Vasant. "Artificial bee colony algorithm for solving optimal power flow problem." *The Scientific World Journal* 2013, 2013.

[38] Ozturk, Ali, et al. "Reactive power optimization with artificial bee colony algorithm." *Scientific Research and Essays* vol 5.19, 2848-2857,2010

[39] Murthy, GV K., S. Satyanarayana, and B. Hanumantha Rao. "Artificial bee colony algorithm for distribution feeder reconfiguration with distributed generation.", 2012.