International Journal of Engineering & Technology, 7 (3.31) (2017) 50-54

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Application of BFOA in Two Area Load Frequency Control

P. Sri Krishna Sarath, I. Swetha Monica*

Department of Electrical and Electronics Engineering, SRKR Engineering College, Bhimavaram, Andhra Pradesh, India- 534204
**Corresponding author E-mail: swethamonica@gmail.com* ; Tel#: +91-9347881883

Abstract

This paper presents Bacterial foraging optimization algorithm which is based on food searching process of Escherichia coli bacteria, which is gaining popularity due to its effectiveness and providing solution to real world optimization problems .BFOA is applied to control the parameter optimization of load frequency controller for tuning the parameters of the proportional integral and derivative controller. A simple two area system with thermal-thermal generating units is considered for simulation study which is controlled with PID controller. The main objective of this work is to design the controller by minimizing objective function .simulation studies demonstrate that our proposed controller is effective and transients are suppressed predominantly

Keywords: *Bacterial foraging optimization algorithm (BFOA); load frequency controller (LFC); Area control error (ACE);*

1. Introduction

LFC is very essential control problem in electrical power system and operation. A large deviation in frequency deviation directly impact on system operation and reliability, in severe cases damage the equipment. Degrade load performance overload the transmission line and cause unstable condition [1 - 6]. The main objective of LFC is to maintain the frequency and tie line power to a predefined value. In LFC problem each area contains its own generating source and shares the load with the neighboring areas [7]. Area load changes and abnormalities cause deviations in frequency and tie line power, these errors are to be rectified by the LFC [8].

In the present day's different electrical power Generation, Transmission and Distribution companies are competing in all aspects to provide more reliable service [9]. So a better control strategy is required to keep the frequency deviation and net interchanged tie line power flow within the prescribed normal values and limit the power losses to the minimum value [10-14].

In this paper PID controller is used and Genetic algorithm is applied to tune the performance index. MATLAB simulation software is used to study the proposed system.

2. Bacterial Foraging Optimization Algorithm

Kevin passion introduced bacterial Foraging Optimization Algorithm (BFOA).it is one of the optimization algorithm inspired by the nature. The main goal of this algorithm is the implementation of foraging strategy of an E.coil bacterium. Bacteria search for nutrient food in a way to maximize its energy content. Individual bacterium also communicates with other bacterium cell by sending signals. By comparing the previous foraging step process it takes foraging decisions. Chemotaxis is a process of searching nutrients in small steps arount its space. The importance of BFOA is its chemotactic movement of virtual bacteria in the problem search space. Bacterial Foraging optimization theory is explained by following steps.

Chemotaxis, Swarming, Reproduction and Eliminational-Dispersal

2.1 Objective Function

BFOA has to minimize the integral of time multiply absolute error of frequency of both the areas and tie line. Objective function J referred to our proposed system is in eq.1and the constraints are in eq. 2, eq.3and eq.4.

$$J=\int_0^\infty t(\Delta f_1 + \Delta f_2 + \Delta p_{tie12})dt \qquad (1)$$

J optimization problem can be stated as: Minimize J subjected to

$$k_p^{min} \le k_p \ge k_p^{max} \qquad (2)$$

$$k_i^{min} \le k_i \ge k_i^{max} \qquad (3)$$

$$k_d^{min} \le k_d \ge k_d^{max} \qquad (4)$$

For simplicity identical two area system is considered that the optimal parameters are same k1=K2=k. The ultimate objective of our study is to tune the PID parameters of by BFOA algorithm. The aim of the optimisation is to find a better optimised controller which is able to restrict the damping oscillations, settling time rise time .peak overshoot and other transient behaviour. Control of frequency of both the areas an tie line power under all operating conditions and provide quality service to the consumers is the ultimate challenge. Initial parameters for the algorithm are tabulated in **Table1**.

In this paper a simple load frequency control two are system with non reheat thermal –thermal system is used for case study is shown in **Figure 1**.

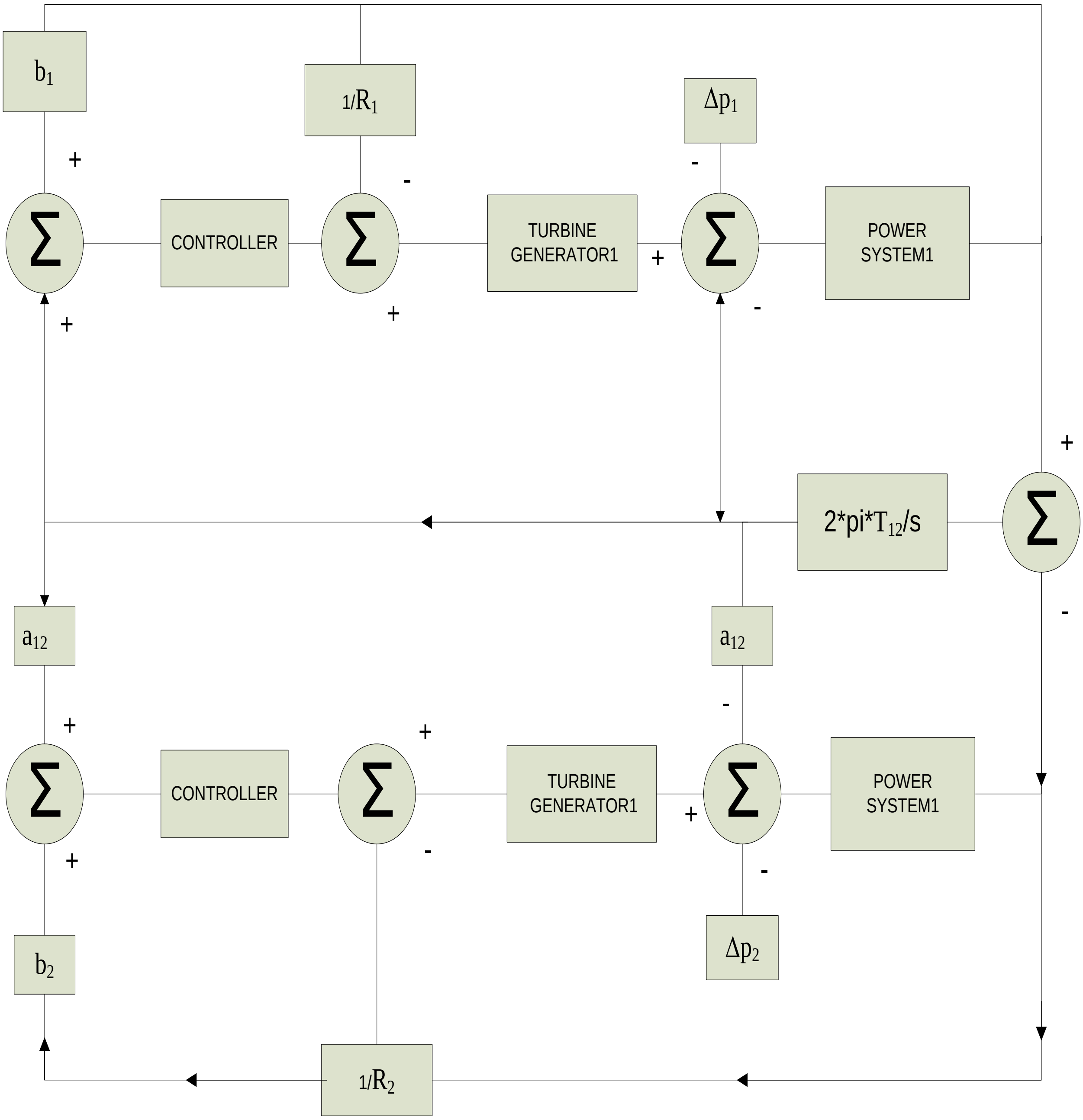

Fig. 1: A simple two area system

Table 1: Initial parameters of BFOA

S.No	Parameters	Values
1	bacterium S number	50
2	Maximum no of steps N_S	4
3	No. of chemotatic steps N_C	100
4	No. of reproduction steps N_{re}	4
5	No. Of elimination and dispersal step N_{ed}	2
6	Probability P_{ED}	0.25
7	Size of step $C(i)$	0.1

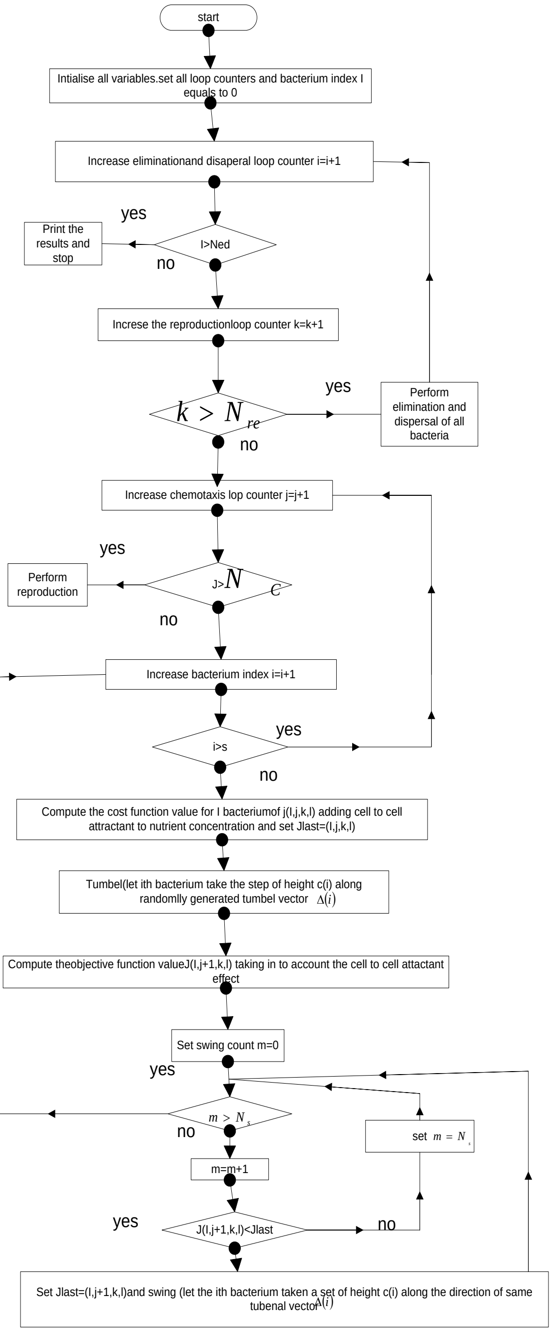

Fig. 2: Flow chart

This will reflect the real world scenario that two thermal neighbour areas are interconnected with tie line as in fig.1.And the BFOA algorithm is represented in pictorial form in **Figure 2**.

3. Simulation Results

All Simulation of LFC two area systems is carried out using MATLAB software. Proposed system is observed for different load conditions in both the areas. In first area 0.1pu step load is increased in area 1 where as in area 2 are without any added load. Similarly 0.1 Pu step load is increased in area 2 keeping area without any added additional load and the results are observed below.

3.1 For Step Increase in the Load Demand in Area 1

As the first test case, at Area 1 when there is 0.1pu load change in area 1Then the fluctuations in area control error in area1 is show in **Figure 3** and fluctuations in area control error in area 2 is shown in **Figure 4** we can observe fluctuations in frequency in area1 is shown in **Figure 5** and also from **Figure 6** we can observe fluctuations of frequency in area 2tie line power deviations is shown in **Figure 7**. All the parameters in figures are compared and tabulated in **Table 2**.

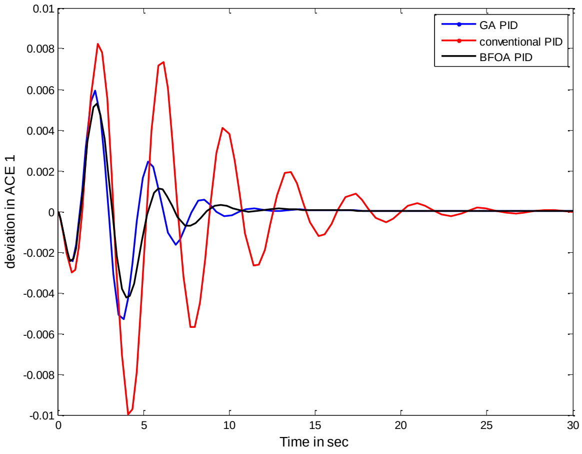

Fig. 3: Deviation in ACE1 with 0.1 p.u load variation in area 1

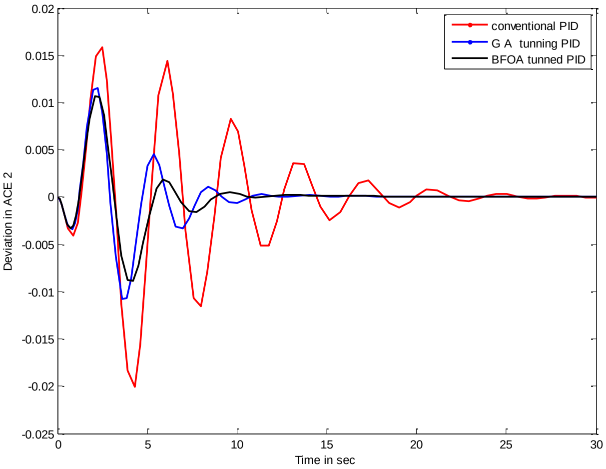

Fig. 4: Deviation in ACE2 with 0.1 p.u load variation in area 1

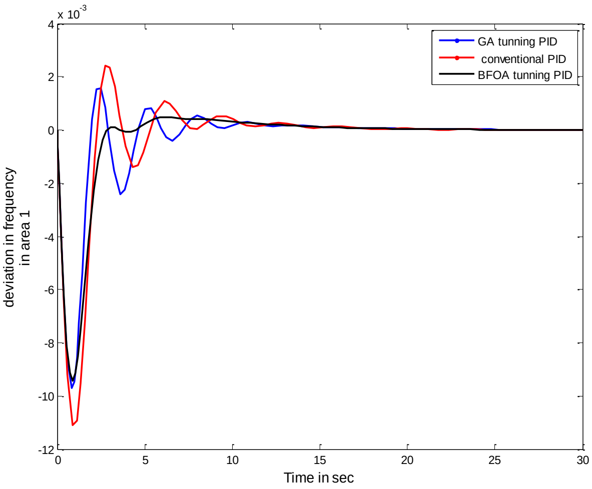

Fig. 5: Deviation in frequency in area 1 with 0.1 p.u load variation in area1

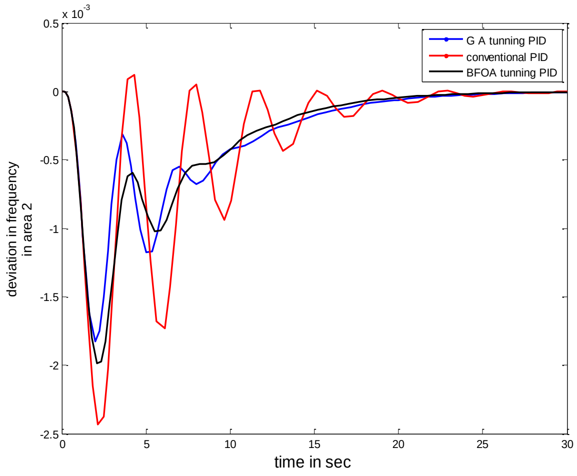

Fig. 6: Deviation in frequency in area 2with 0.1 p.u load variation in area 1

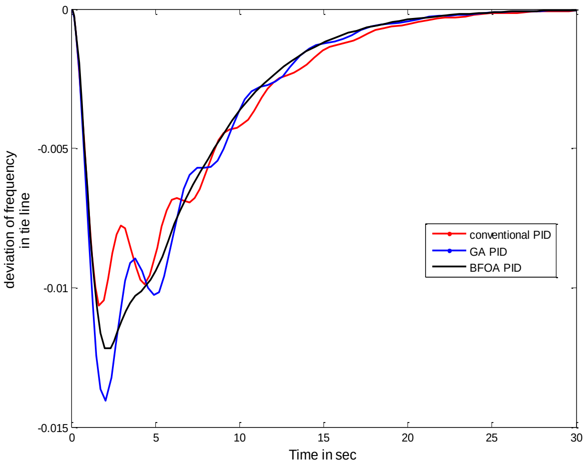

Fig. 7: Deviation in frequency in tie line with 0.1 p.u load variation in area1

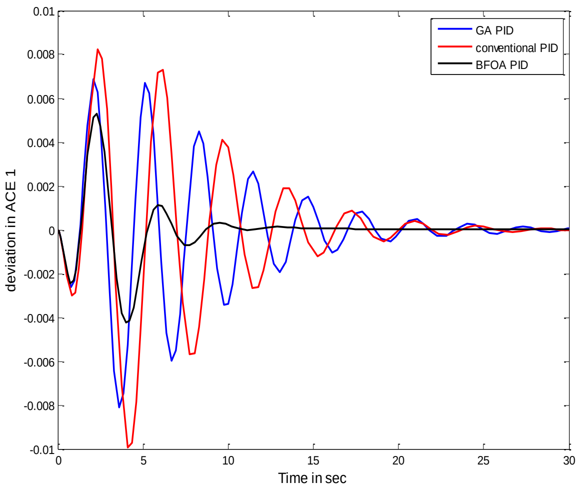

Fig. 8: Deviation in ACE 1 with 0.1 p.u load variation in area 2

Table 2: Comparison of various parameters when step load change in aera1

Case 1		**Conventional PID**	**GA PID**	**BFOA PID**
ACE in area 1	Settling time (sec)	26	15	12
	Maximum peak(Hz)	0.008	0.006	0.005
ACE in area 2	Settling time(sec)	26	17	12
	Maximum peak(Hz)	0.017	0.02	0.01
Frequency deviation in area 1	Settling time(sec)	20	15	12
	Maximum peak(Hz)	-11	-9	-7
Frequency deviation in area 2	Settling time(sec)	27	25	24
	Maximum peak(Hz)	-2.4	-1.75	2
Tie line frequency	Settling time (sec)	27	25	24
	Maximum peak(Hz)	-0.02	-0.014	-0.05

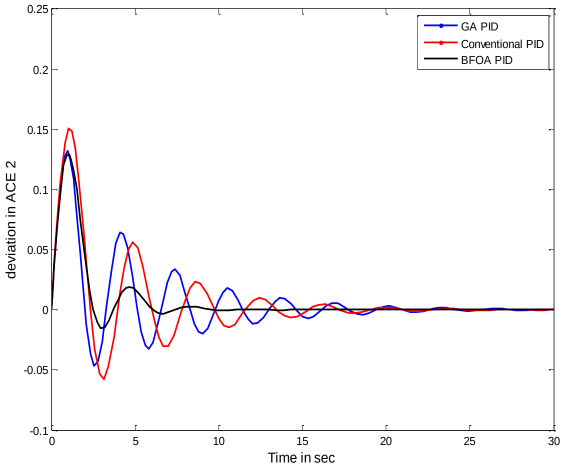

Fig. 9: Deviation in ACE 2 with 0.1 p.u load variation in area 2ea1

3.2. For Step Increase in the Load Demand in Area 2

As the second test case, at Area 2 a step increase in load is applied. when there is 0.1pu load change in area 2Then the fluctuations in area control error in area1 is show in **Figure 8** and fluctuations in area control error in area2 is shown in **Figure 9**. We can observe fluctuations in frequency in area1 are shown in **Figure 10**. From **Figure 11**, we can observe fluctuations of frequency in area 2.tie lin power deviations is shown in **Figure 12**. All the parameters in figures are compared and tabulated in **Table 3**.

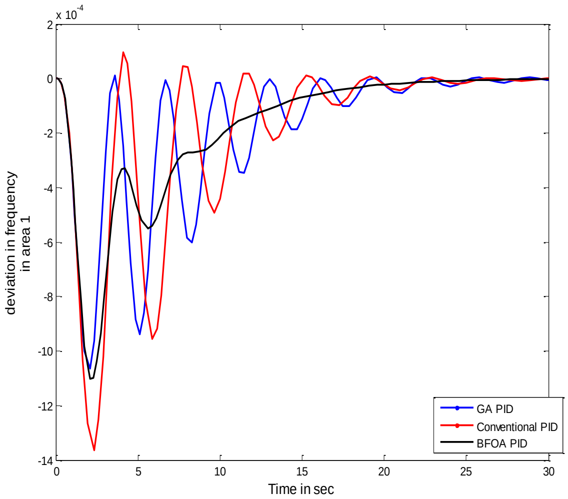

Fig. 10: Deviation in frequency in area 1with 0.1 p.u load variation in area2

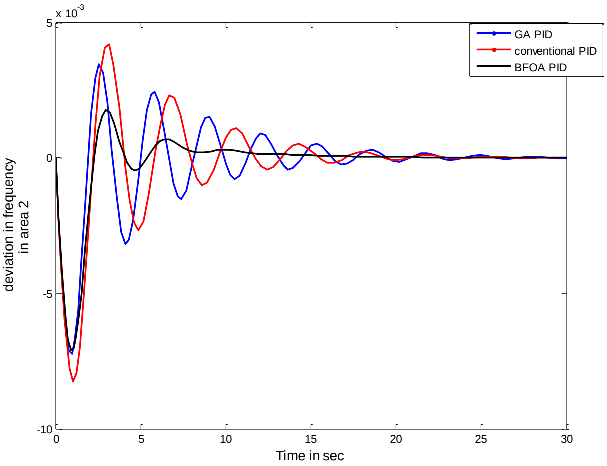

Fig. 11: Deviation in frequency in area 2 with 0.1 p.u load variation in Area 2

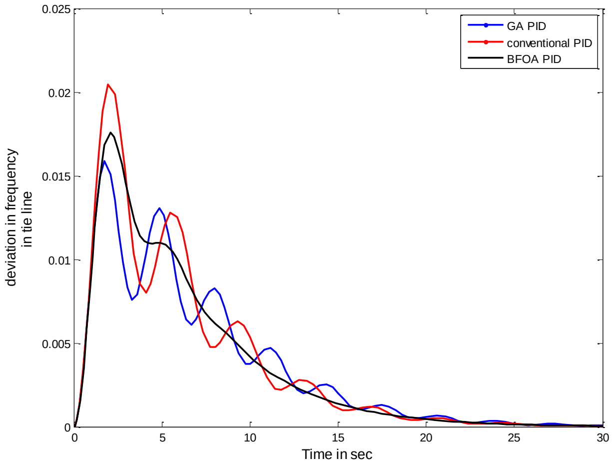

Fig. 12: Deviation in frequency in tie line with 0.1 p.u load variation in Area 2

Table 3. comparisons of various parameters when step load change in area2

Case 2		**Conventional PID**	**GA PID**	**BFOA PID**
ACE in area 1	Settling time (sec)	30	30	15
	Maximum peak(Hz)	0.008	0.006	0.005
ACE in area 2	Settling time(sec)	25	24	10
	Maximum peak(Hz)	0.15	0.8	0.7
Frequency deviation in area 1	Settling time(sec)	30	29	22
	Maximum peak(Hz)	-0.0013	-0.0011	-0.0115
Frequency deviation in area 2	Settling time(sec)	27	25	15
	Maximum peak(Hz)	-0.008	-0.007	-0.007
Tie line frequency	Settling time (sec)	29	28	27
	Maximum peak(Hz)	0.02	0.016	0.018

4. Conclusion

Power system is never stable it is only quasi stable, because of the load fluctuations .Due to these fluctuations area control error gets accelerated. A simple two area test system is demonstrated and BFOA is used to tune the PID parameters by taking integral time absolute error of both the areas as the input objective function. Simulation results clearly shows that our proposed method predominantly restricts the oscillatory behavior of the system comparatively to genetic algorithm tuned PID and other conventional controllers, settling time and rise time has decreased significantly. Due to its simplicity and adaptiveness it can be used to real world problems.

References

[1] Kundur P., Power system stability and control. *McGraw-Hill;* 1994.

[2] Yang T.C., Cimen H., Zhu Q.M., “Decentralized load frequency controller design based on structured singular values”, *IEEE Proc-Gener, Trans Distrib.*, 145, 1, (1998) 7–14.

[3] Rerkpreedapong D., Hasanovic A., Feliachi A. “Robust load frequency control using genetic algorithms and linear matrix inequalities”, *IEEE Trans Power Syst*., 18, (2003) 855–861.

[4] Zribi M., Al-Rashed M., Alrifai M., “Adaptive decentralized load frequency control of multi area power systems”, *Int J. Electr Power Energy Sys.*, 27, 8, (2005) 575–583.

[5] Çam E., Kocaarslan I., “Fuzzy logic controller in interconnected electrical power systems for load frequency control”, *Int. J. Electr. Power Energy Syst.*, 27, 8, *(*2005), 542-549.

[6] Pothiya S., Ngamroo I., Runggeratigul S., Tantaswadi P., “Design of optimal fuzzy logic based PI controller using multiple tabu search algorithm for load frequency control” *Int. J. Contr. Auto. Syst.* 4, 2, (2006), 155–164.

[7] Taher S., Hematti R., Abdolalipour A., Tabei S. H., “Optimal decentralized load frequency control using HPSO algorithms in deregulated power systems”, *Am. J. Appl. Sci.*, 5, 9, (2008), 1167–1174.

[8] Shayeghi H., Jalili A., Shayanfar H.A., “Multi stage fuzzy load frequency control using PSO”, *Int. J. Energy Conver Manage,* 49, 10 (2008), 2570–2580.

[9] Sabahi K., Sharifi A., Aliyari M., Teshnehlab M., Aliyghary M., “Load frequency controller in interconnected power system using multi objective PID controller”, *J. Appl. Sci.* 8, 20, (2008), 3676–3682.

[10] Panda G., Panda S., Ardil C., “Automatic generation control of interconnected power system with generation rate constraints by hybrid neuro fuzzy approach”, *Int. J. Electr. Power Energy Syst Eng* 2, 1, (2009),13–18.

[11] Ramesh S., Krishnan A., “Modified genetic algorithm based load frequency controller for interconnected power system”, *Int. J. Electr. Power Eng.* 3,1, (2009), 26–30.

[12] Aravindan P., Sanavullah M.Y., “Fuzzy logic based automatic frequency control of two area power system with GRC” *Int. J. Comput. Intell Res.*, 5, 1, (2009), 37–44.

[13] Ford J.J., Bevrani H., Ledwich G., “Adaptive load shedding and regional protection”, *Int. J. Electr. Power Energy Syst.*, 31, 10, (2009), 611–618.

[14] Roy R., Bhatt P., Ghoshal S.P., “Evolutionary computation based three area automatic generation control”, *Int. J. Electr. Power Energy Syst.*, 37, 8, (2010), 5913-5924.