Dynamic Stability Enhancement Of Ieee 30 Bus System With Gapod And Gadcvr Controllers Based Upfc

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***ABSTRACT: This paper proposes a combination of Genetic Algorithm based Power Oscillation Damping (GAPOD) and DC Voltage Regulator (DCVR) controllers are proposed for Unified Power Flow Controller (UPFC) for the enhancement of dynamic stability of IEEE 30 bus system. The difference between mechanical power and electrical power is the input to the GAPOD, and the output of GAPOD is connected to UPFC one of the input and the input of GADCVR is deviations of capacitor voltage and this output connected to another input of UPFC. GA tunes the parameters of POD and DCVR by minimizing the error; this error is the difference between mechanical and electrical power. The proposed method is applied to IEEE 30 bus system in MATLAB/Simulink environment, and results compared with Genetic Algorithm based Multi Stage Fuzzy DC Voltage Regulator (GAMSFDCVR) and conventional controllers. The results demonstrated that the proposed controller is effectively damping the oscillations*.

Key words: Genetic Algorithm based Power Oscillation Damping (GAPOD), Genetic Algorithm based Multi Stage Fuzzy DC Voltage Regulator (GAMSFDCVR).

1. INTRODUCTION

The dynamic stability analysis and improvement of the interconnected power system play a vital role in the present scenario; generally, conventional power system stabilizers are in operation for damping these oscillations [1]-[2]. Sometimes, specifically under heavy load conditions of transmission lines, these controllers are not enough to damp these oscillations. An alternative solution for this problem is FACTs devices; among FACTs devices, UPFC is a critical device due to its special properties [3]-[4]. UPFC alone cannot damp the oscillations effectively, so additional controllers are required for this [5]. Three supplementary controllers are used initially for UPFC to soften the low-frequency oscillations [6]-[7]. The parameters of these controllers are fixed and not robust, so the significant damping capability is reduced.
Fuzzy supplementary controller proposed by wang et al. for UPFC to damp the oscillations effectively [8]. Multiple series controllers are offered for UPFC in an interconnected power system by Lo et al [9]. Hybrid fuzzy controller [10] was used for the series controller, and fuzzy logic controller [11] proposed UPFC for effective damping of low-frequency oscillations. Khan et al. proposed Fuzzy Logic Controller based hybrid micro genetic algorithm (HMGA) for UPFC, here the fuzzy bounds are tuned by using HMGA [12] and GA

based FLC used for UPFC by Mok et al.,[13].

The methods proposed by many authors are not effective if the transmission line is heavily loaded under that situation UPFC requires a reliable and most robust controller for enhancing the stability. This paper proposed a novel method in which POD controller-based UPFC is used for damping the oscillation, and also, the parameters of this controller are adjusted by the genetic algorithm by minimizing the error objective function. The objective function is the error caused by the difference between mechanical power and electrical power.

2. PROPOSED METHOD (GAPOD & GADCVR CONTROLLERS)

Integer The structure of GAPOD is similar to the conventional power system stabilizer. It consists of a gain block for providing suitable damping magnitude, two or more lead-lag blocks for providing leading angle to aid the damping magnitude in the correct situation, washout block acting as an electronic switch which recognizes the oscillations and closing the switch. The DC voltage regulator is PI type; GA tunes the parameters of gain of propositional and integral.

GA tunes a total of five parameters, three for POD and two for DCVR. The following procedure is applied for this process:

Step 1: Initialize all parameters like initial values of POD and DCVR, population and generation number, the maximum number of iterations, mutation, and crossover values.

Step 2:With initial values, calculate the fitness value of the problem using the following equations.

$$ITAE = \int_0^t t|\Delta P| \ ; \ Fitness = \frac{1}{10*ITAE}$$

Step 3: Generate new population and generation using crossover, mutation and selection process.

Step 4: Calculate the fitness value after run the simulation.

Step 5: Check the fitness condition, if satisfied go to step 7, otherwise go to step 4

Step 6: Increase the iteration by one and repeat the procedure from step 3 to step 5

Step 7: After completing all the iterations or condition is satisfied, then stop the procedure and return the results.

3. SIMULATION DIAGRAM & RESULTS

MATLAB/Simulink diagram of IEEE 30 bus system with GAMSFDCVR based UPFC is shown in fig.1. Here UPFC is installed in line connected between buses 2 and 5.

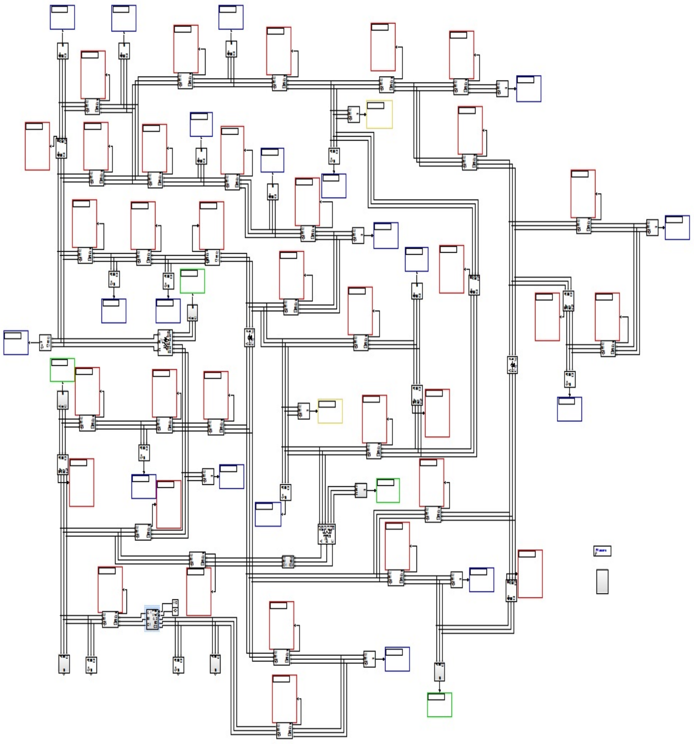

Figure 1: MATLAB/Simulink diagram of IEEE 30 bus system.

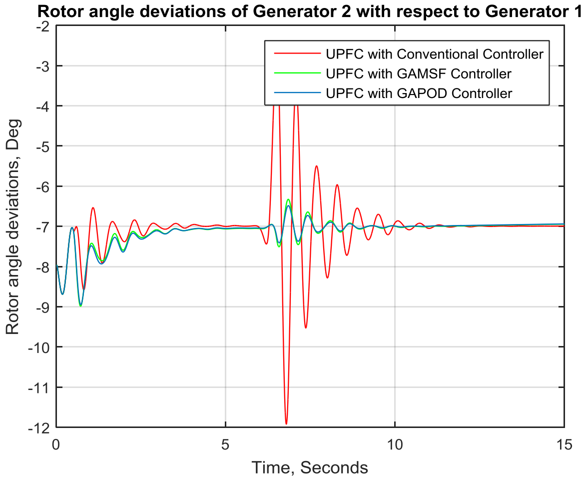

Figure 2: Rotor angle deviations of machine 2 with respect to machine 1

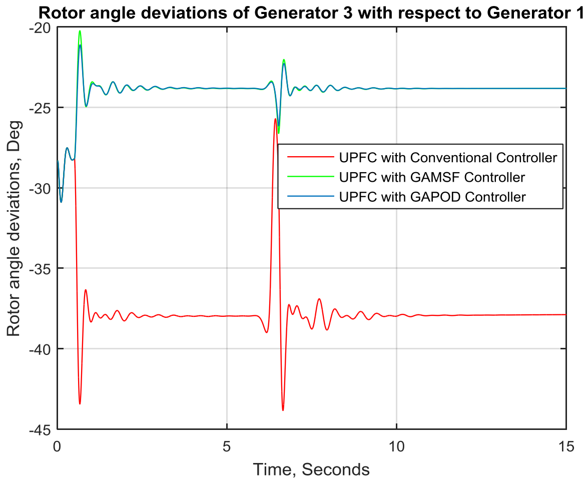

Figure 3: Rotor angle deviations of machine 3 with respect to machine 1

Figure 4: Rotor angle deviations of machine 4 with respect to machine 1

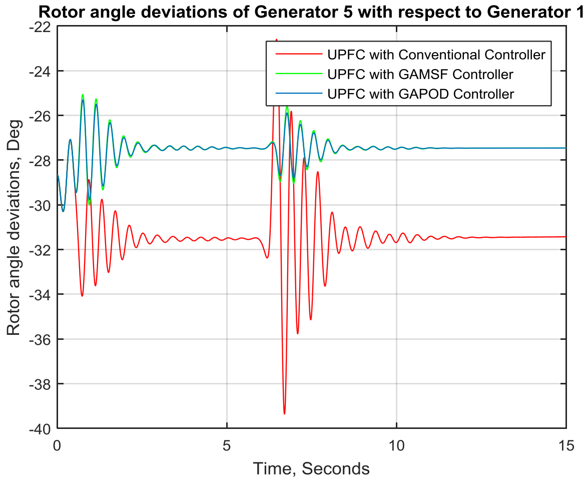

Figure 5: Rotor angle deviations of machine 5 with respect to machine 1

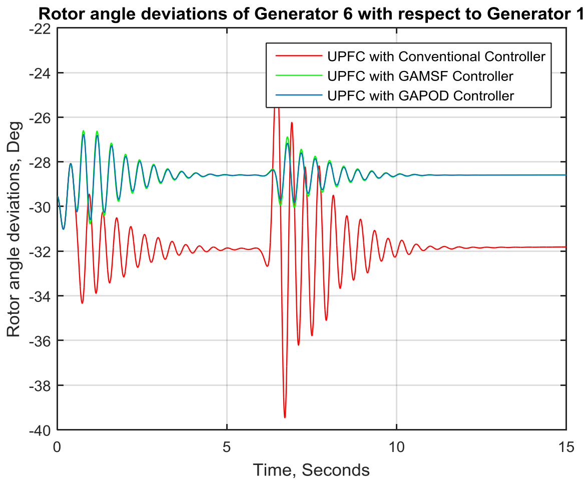

Figure 6: Rotor angle deviations of machine 6 with respect to machine 1

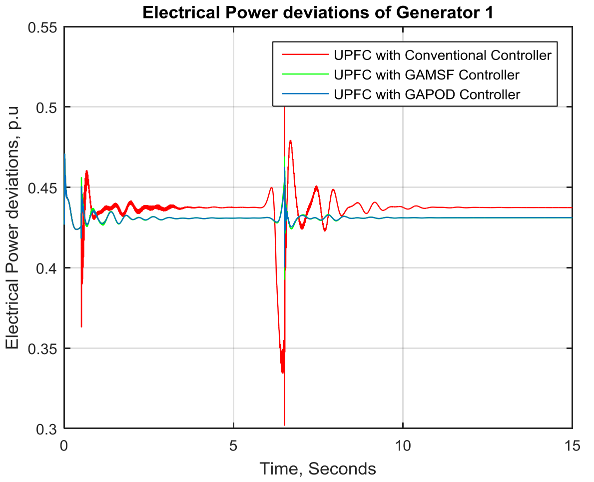

Figure 7: Electrical power deviations of machine 1 with respect to time

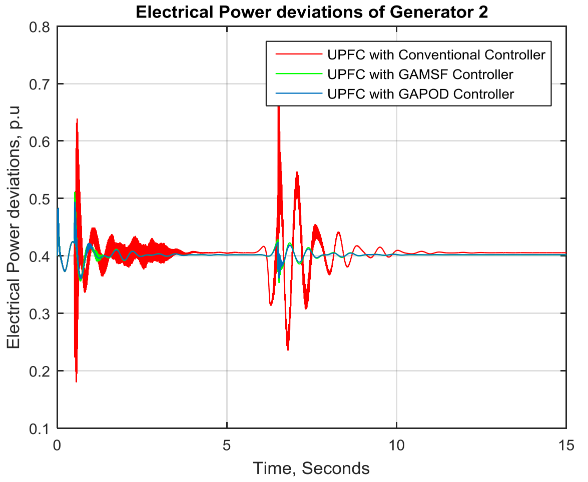

Figure 8: Electrical power deviations of machine 2 with respect to time

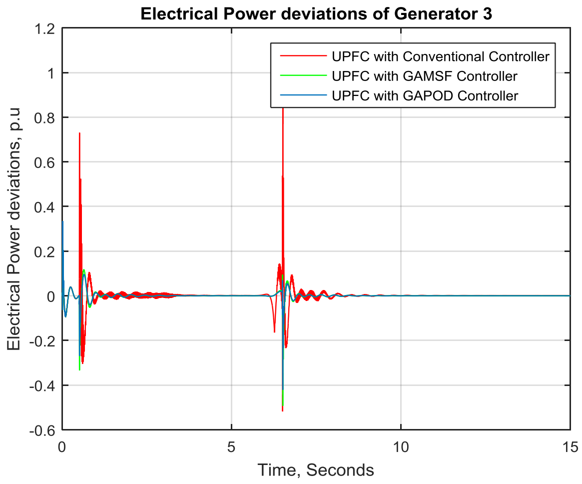

Figure 9: Electrical power deviations of machine 3 with respect to time

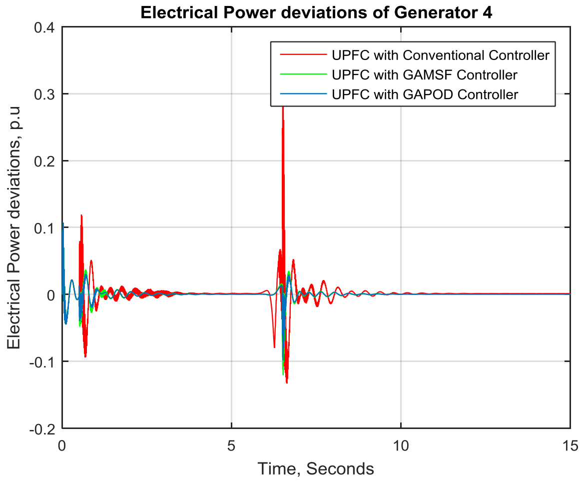

Figure 10: Electrical power deviations of machine 4 with respect to time

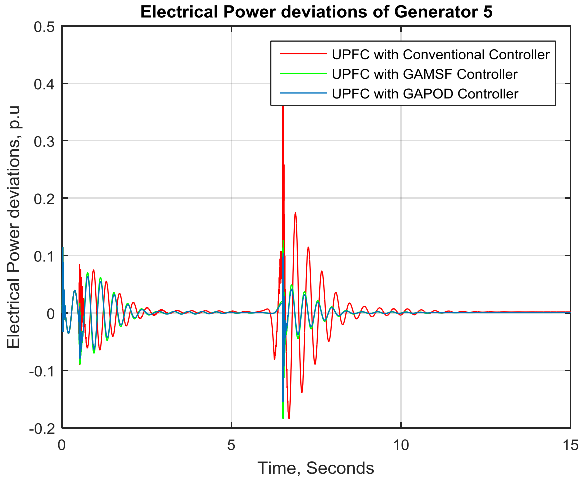

Figure 11: Electrical power deviations of machine 5 with respect to time

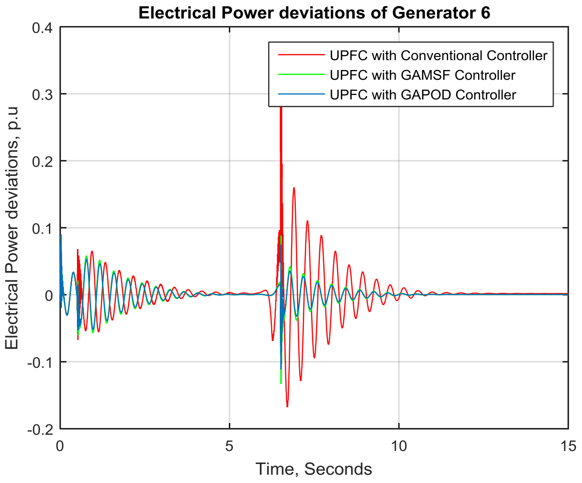

Figure 12: Electrical power deviations of machine 6 with respect to time

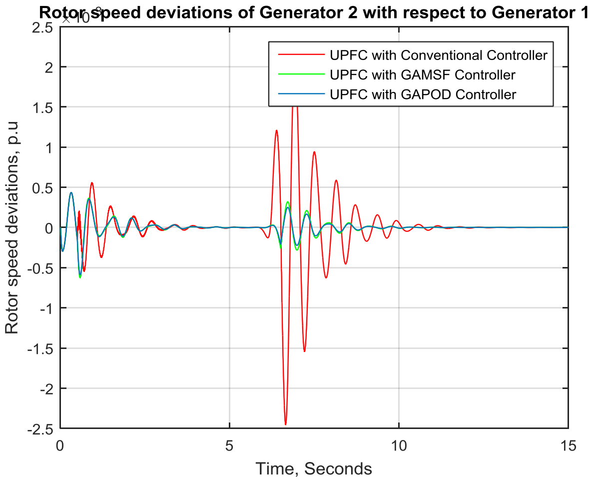

Figure 13: Rotor speed deviations of machine 2 with respect to machine 1

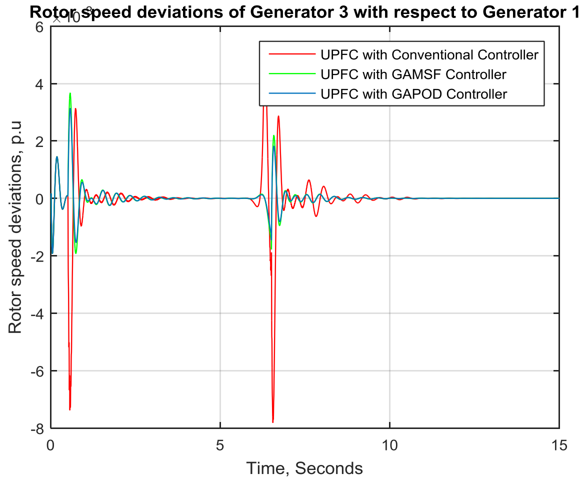

Figure 14: Rotor speed deviations of machine 3 with respect to machine 1

Figure 15: Rotor speed deviations of machine 4 with respect to machine 1

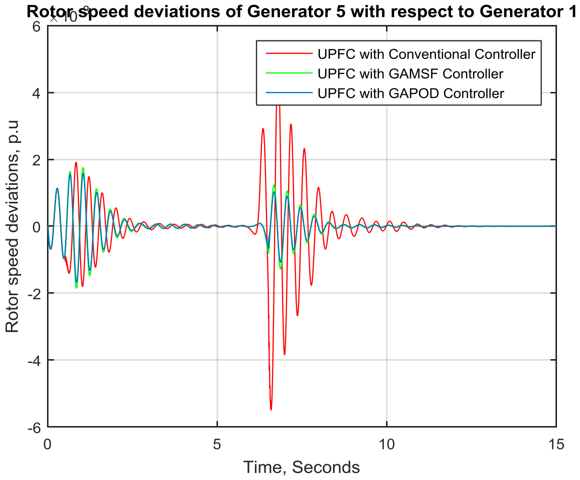

Figure 16: Rotor speed deviations of machine 5 with respect to machine 1

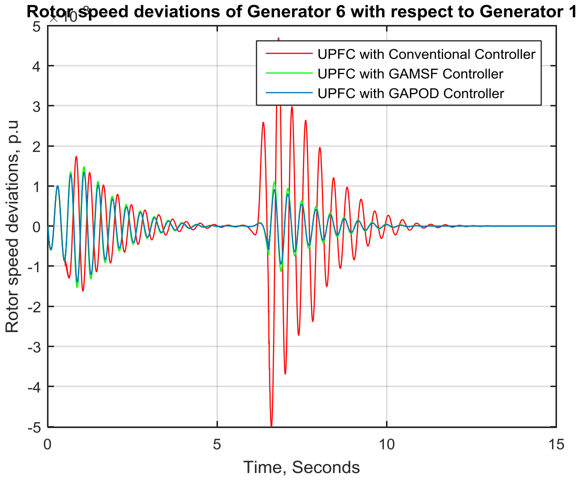

Figure 17: Rotor speed deviations of machine 6 with respect to machine 1

Fig.2 shows the rotor angle deviations of generator 2 with respect to generator 1, from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controllers and GAMSFDCVR controller. Fig.3 shows the rotor angle deviations of generator 3 with respect to generator 1, from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controllers and GAMSFDCVR controller. Fig.4 shows the rotor angle deviations of generator 4 with respect to generator 1, from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controllers and GAMSFDCVR controller. Fig.5 shows the rotor angle deviations of generator 5 with respect to generator 1, from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controllers and GAMSFDCVR controller. Fig.6 shows the rotor angle deviations of generator 6 with respect to generator 1, from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controllers and GAMSFDCVR controller.

Fig.7 shows the electrical power deviations of generator 1 with respect to time; from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controller and GAMSFDCVR controller. Fig.8 shows the electrical power deviations of generator 2 with respect to time; from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controller and GAMSFDCVR controller. Fig.9 shows the electrical power deviations of generator 3 with respect to time; from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controller and GAMSFDCVR controller. Fig.10 shows the electrical power deviations of generator 4 with respect to time; from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controller and GAMSFDCVR controller. Fig.11 shows the electrical power deviations of generator 5 with respect to time; from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controller and GAMSFDCVR controller. Fig.12 shows the electrical power deviations of generator 6 with respect to time; from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controller and GAMSFDCVR controller.

Fig.13 shows the rotor speed deviations of generator 2 with respect to generator 1, from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controllers and GAMSFDCVR. Fig.14 shows the rotor speed deviations of generator 3 with respect to generator 1, from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controllers and GAMSFDCVR. Fig.15 shows the rotor speed deviations of generator 4 with respect to generator 1, from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controllers and GAMSFDCVR. Fig.16 shows the rotor speed deviations of generator 5 with respect to generator 1, from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controllers and GAMSFDCVR Fig.17 shows the rotor speed deviations of generator 6 with respect to generator 1, from this figure it is clear that the proposed controller is effectively damping the oscillations as compared with conventional controllers and GAMSFDCVR

4. CONCLUSION

In this paper, a new controller is proposed for dynamic stability enhancement of Multi-machine power system. This controller is designed in MATLAB/Simulink and applied on SMIB system, from the results discussion it clear that the proposed method is effectively damping the oscillations compared with existing method.

5. REFERENCES

(Periodical style)

[1] Y.H. Song, A.T. Johns, Flexible AC transmission systems (FACTS), UK: IEE Press; 1999.
[2] N.G. Hingorani, L. Gyugyi, Understanding FACTS: Concepts and technology of flexible AC transmission systems, Wiley-IEEE Press; 1999.
[3] L. Gyugyi, Unified power-flow control concept for flexible ac transmission systems, IEE Proc. On Generation, Transmission and Distribution, Vol. 139 No. 4, 1992, pp. 323-31.
[4] IEEE Power Engineering Society and CIGRE, FACTS overview, IEEE Publication No. 95 TP 108, 1995.
[5] M. Vilathgamuwa, X. Zhu, S.S. Choi, A robust control method to improve the performance of a unified power flow controller, Electric Power Systems Research, Vol. 55, 2000, pp.103-11.
[6] N. Tambey, M.L. Kothari, Damping of power system oscillations with unified power flow controller (UPFC), IEE Proc. On Generation, Transmission and Distribution, Vol. 150, No. 2, 2003; pp. 129-40.
[7] M.M. Farsangi, Y.H Song, K.Y. Lee, Choice of FACTS device control inputs for damping inter-area oscillations, IEEE Trans. On Power Systems, Vol. 19, No. 2, 2004, pp. 1135-43.
[8] P.K. Dash, S. Mishra, G. Panda, A radial basis function neural network controller for UPFC, EEE Trans. On Power Systems, Vol. 15, No. 4, 2000, pp. 1293-9.
[9] L-X. Wang, A course in fuzzy systems and control, NJ: Prentice Hall; 1997.
[10] P.K. Dash, S. Mishra, G. Panda, Damping multimodal power system oscillation using hybrid fuzzy controller for series connected FACTS devices, IEEE Trans. on Power Systems, Vol. 15, No. 4, 2000, pp. 1360- 1366.
[11] S. Limyingcharone, U.D. Annakkage, N.C. Pahalawaththa, Fuzzy logic based unified power flow controllers for transient stability improvement, IEE Proc. On Generation, Transmission and Distribution, Vol. 145, No. 3, 1998, pp. 225-232.
[12] L. Khon, K. L. Lo., Hybrid micro-GA based FLCs for TCSC and UPFC in a multi machine environment, Electric Power Systems Research, Vol. 76, 2006, pp. 832-843
[13] T.K. Mok, H. Liu, Y. Ni, F. F. Wu, R. Hui, Tuning the fuzzy damping controller for UPFC through genetic algorithm with comparison to the gradient descent training, Electric Power and Energy Systems, Vol. 27, 2005, pp. 275-283.
[14] 14 Sankaraiahmogaligunta and R.Sreeramakumar, A New POD controller for UPFC for damping low frequency oscillations in power systems, Proc of National Symposium for Post Graduate Students (NSPGS 2010), 24-25 April 2010, Vol. 2 – Electrical Sciences, pp. 301-306