

the RBFNN identifier and ANFC .

6 Acknowledgment

This work is supported by the Major Project of Postgraduate Education Reform of Chongqing (No. yjg131001).

Appendix A. System parameters

All data are in p.u. unless specified otherwise.

Synchronous generator

Rotor Type: Salient-pole, Pole Pairs: 32, Nominal Power: 200MVA, Line to Line Voltage: 13.8kV, $f=50\text{Hz}$, $x_d=1.305$, $x'_d=0.296$, $x''_d=0.252$, $x_q=0.474$, $x'_q=0.243$, $x''_q=0.18$, $T'_d=1.01s$, $T''_d=0.053s$, $T_{q0}=0.1s$, $R_s=2.8544\times 10^{-3}$, Inertia Factor: 3.2, Friction Factor: 0.

Hydraulic turbine and governor (HTG)

Servo Motor: $K_A=3.33$, $T_A=0.07s$, $G_{\min}=0.01$, $G_{\max}=0.9752$, $V_{g\min}=-0.1pu/s$, $V_{g\max}=0.1pu/s$; Permanent Droop and PID Regulator: $R_p=0.05$, $K_p=1.163$, $K_i=0.105$, $K_d=0$, $T_d=0.01s$.
Hydraulic Turbine: $\beta=0$, $T_w=2.67s$.

AVR and excitation system

Low pass Filter Time Constant: $T_r=0.02s$; Regulator Gain and Time Constant: $K_a=300$, $T_a=0.001s$; Exciter: $K_e=1$, $T_e=0s$; Transient Gain Reduction: $T_b=0s$, $T_c=0s$; Damping Filter Gain and Time Constant: $K_f=0.001$, $T_f=0.1s$; Regulator Output Limits and Gain: $E_{f\min}=-11.5$, $E_{f\max}=11.5$, $K_p=0$.

Power transformer

Nominal Power: 200MVA, 13.8/230kV, $f=50\text{Hz}$, D_1/Y_g connection; Winding 1 and Winding 2 Parameters: $R_1=0.0027$, $L_1=0.08$, $R_2=0.0027$, $L_2=0.12$; Magnetizing Resistance and Reactance: $R_m=500$, $L_m=500$.

References:

- [1] E. V. Larsen and D. A. Swann, "Applying power system stabilizers, parts I and II", *IEEE Trans. PAS*, vol. 100, pp. 3017-3046, 1981.
- [2] Michael J. Baler, Richard C. Schaefer, "Understanding power-system stability", *IEEE Transactions on Industry Applications*, vol. 44, no. 2, pp. 37-47, April 2008.
- [3] Kamwa R. Grondin, and G. Trudel, "IEEE

PSS2B versus PSS4B: The limits of performance of modern power system stabilizers", *IEEE Transactions on Power Systems*, Vol. 20, No. 2, pp. 903-915, May 2005.

- [4] M. Soliman, A.L. Elshafei, F. Bendary, and W. Mansour, "LMI static output-feedback design of fuzzy power system stabilizers", *Expert Systems with Applications*, Volume 36, pp. 6817-6825, 2009.
- [5] M.Caner, N.Umurkan, S. Tokat, S.V. Ustun, "Determination of optimal hierarchical fuzzy controller parameters according to loading condition with ANN", *Expert Systems with Applications*, Volume 34, pp. 2650-2655, 2008.
- [6] Lokman H.Hassan, M.Moghavvemi, Haider AF. Almurib, K.M. Muttaqi, H.Du, "Damping of low-frequency oscillations and improving power system stability via auto-tuned PI stabilizer using Takagi-Sugeno fuzzy logic", *International Journal of Electrical Power & Energy Systems*, Volume 38, No. 1, pp. 72-83, June 2012.
- [7] S.M. Radaideh, I.M. Nejdawi, M.H. Mushtaha, "Design of power system stabilizers using two level fuzzy and adaptive neuro-fuzzy inference systems", *International Journal of Electrical Power & Energy Systems*, Volume 35, No. 1, pp. 47-56, February 2012.
- [8] A.T. Al-Awami, Y.L. Abdel-Magid, M.A. Abido, "A particle swarm-based approach of power system stability enhancement with unified power flow controller", *Electric Power and Energy Systems*, Volume 29, pp. 251-259, 2007.
- [9] Jesus Fraile-Ardanuy, P.J. Zufiria, "Design and comparison of adaptive power system stabilizers based on neural fuzzy networks and genetic algorithms", *Neurocomputing*, Volume 70, Issues 16-18, pp. 2902-2912, October 2007.
- [10] K. Sebaa, M. Boudour, "Optimal locations and tuning of robust power system stabilizer using genetic algorithms", *Electric Power Systems Research*, Volume 79, pp. 406-416, 2009.
- [11] A.M. El-Zonkoly, A.A. Khalil, and N.M. Ahmied, "Optimal tuning of lead-lag and fuzzy logic power system stabilizers using particle swarm optimization", *Expert Systems with Applications*, Volume 36, pp. 2097-2106, 2009.
- [12] A. Chatterjee, V. Mukherjee, S.P. Ghoshal, "Velocity relaxed and craziness-based swarm optimized intelligent PID and PSS controlled AVR system", *International Journal of Electrical Power & Energy Systems*, Volume 31, Issues 7-8, pp. 323-333, September, 2009.
- [13] S.P. Ghoshal, A. Chatterjee, V. Mukherjee,

