FREQUENCY STABILIZATION OF MULTI AREA POWER SYSTEM USING ADAPTIVE NEURO FUZZY INTERFACE SYSTEM AND SUPPORT VECTOR MACHINE APPROACH

Ms. Tejaswi shelke[1], Ms. Vaishali Chavhan[2]

[1]Student, G.H.Raisoni University, Amravati
[2]Prof. G.H.Raisoni University, Amravati

ABSTRACT: *Modern Power Systems Present an Energy Mix that comes with an Increasing Number of Powers Electronics-Based Devices like Energy Storage Systems, solar energy Systems, High Voltage DC Links, Etc. These Devices don't Have Inherent Inertia Like Traditional Systems to Counteract Frequency Deviations During Disturbances like Load Imbalance. A Virtual Inertia Controller in An Energy Storage System Is Presented during this Paper to Mitigate the Frequency Instability During System Disturbances. symbolic logic Control Is Proposed as An Intelligent Control Technique to supply Adequate Inertia Response to Drive the System Back to Steady State During Load Disturbance. The Concept of Support Vector Control is additionally wont to Drive the Steady State During Load Disturbance. The system was modelled and analyzed using MATLAB/ Simulink software.*

Keyword*— fuzzy logic control, Neural network, power systems stability, renewable energy and virtual inertia.*

01. Introduction

Preamble:

To meet the growing demand of electricity, it's necessary to harness various sources of power generation. Renewable energy, which appears to be a promising solution has gained prominent attention over the previous couple of decades. However, the mixing of renewable energy systems can significantly reduce the general inertia of the facility system thereby making the system susceptible to frequency and voltage fluctuations. this suggests that tackling the difficulty of power penetration from renewable sources don't solely believe ride through capabilities but frequency response and power regulation during system disturbances.

Aim:

This paper proposes the addition of HVDC links for inter-area power transmission and use of adaptive neuro fuzzy interface system and support vector machine approach as an impact scheme adopted in an energy storage system to supply virtual inertia during load perturbations and wind generation variation

Objectives:

1. To review the prevailing multi area power grid.

2. To review the Fourier, transform analysis-based techniques.

3. To review the prevailing FFT, adaptive neuro fuzzy interface system and support vector machine approach analysis-based techniques for multi area power grid analysis and detection.

.

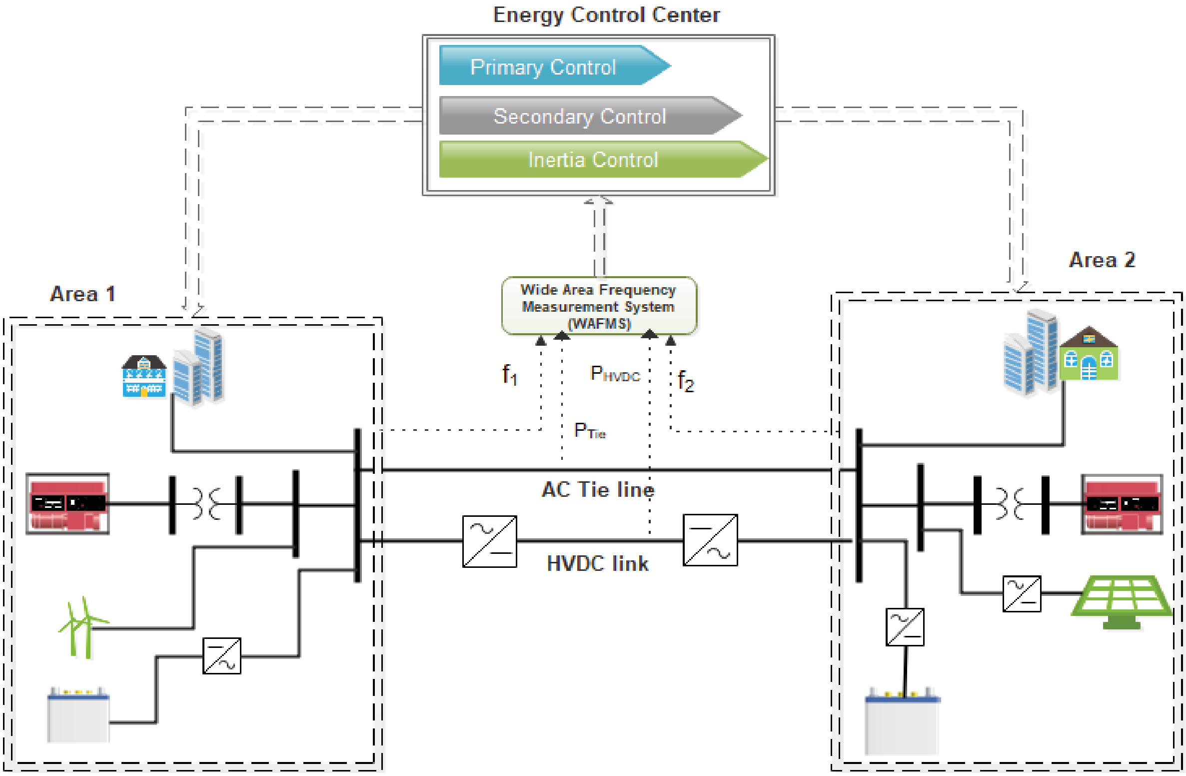

Fig. 1. Pictorial diagram of a two-area interconnected system with parallel ac/ac lines.

System modelling:

In conventional power systems that involve rotating masses, the kinetic energy is a function of the inertia. The overall kinetic energy present in a system is given as

$$E=\frac{1}{2}mJ^2$$

where J is the moment of inertia in the system in kgm^2 and m Is the angular frequency in rad/s.

For a rotating mass, the rate of change of angular frequency of the rotor depends on the difference in mechanical and electrical torque (T_N and T_e). The torque equation commonly referred to as "swing equation".

FUZZY LOGIC CONTROL

A fuzzy logic control (FLC) system is an intelligent control system that has found application in various fields of science and engineering [21]. A basic structure of a FLC system is shown in Fig. 3. It consists of a fuzzification process where the crisp input is converted to a fuzzy input, an inference engine that uses the rule base system to determine the fuzzy output and a defuzzification process that converts the fuzzy output into the crisp output is needed by the system. The rules in a FLC are determined by the IF-THEN statements [22].

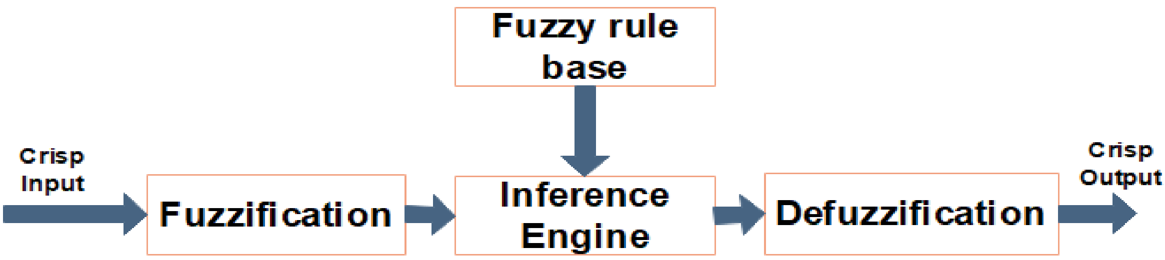

Fig. 2 Basic structure of a FLC system.

In this work, the FLC system consist of two inputs (frequency deviation and derivation of frequency deviation) and one output (inertia gain) as shown in Fig. 4. The output of the controller tunes the gain for the ESS to efficiently provide the necessary power to mitigate the frequency deviation. The rules of the FLC system are provided in Table

I. The performance of the designed fuzzy controller is evaluated with a conventional derivative controller.

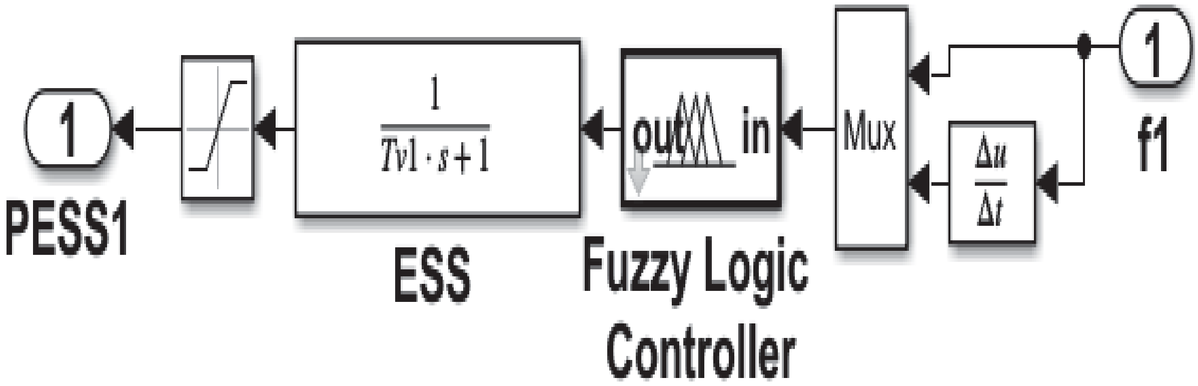

Fig. 3. Energy storage system with fuzzy logic controller

RESULTS DISCUSSIONS IN PREVIOUSLY PAPER

To analyses the performance of the proposed controller under system disturbance, a 10 % (0.1 p.u) step load increase in Area 1 is simulated. Fig. 4 shows the frequency response of the system. It is obvious the frequency oscillations of the ac system (blue line) is damped when a HVDC link is added to the system (orange line). The robustness of the fuzzy logic virtual inertia controller can be observed (purple line) because it reduces the frequency deviation of the system by providing the needed power with a faster response that the derivative virtual inertia controller (yellow line).

To further investigate the performance of the fuzzy logic controller and effect of inertia in the system, the inertia constant of the system is reduced by 50 % and load perturbation is simulated to observe the frequency response of the system as shown in Fig. 5. It is observed that reduction in system inertia increases the frequency deviation in both areas, the oscillations in Area 1 are also increased but effectively damped by the HVDC link. The effectiveness of the ESS with fuzzy logic control is observed with least frequency deviation, fastest response time and shortest time to reach steady state.

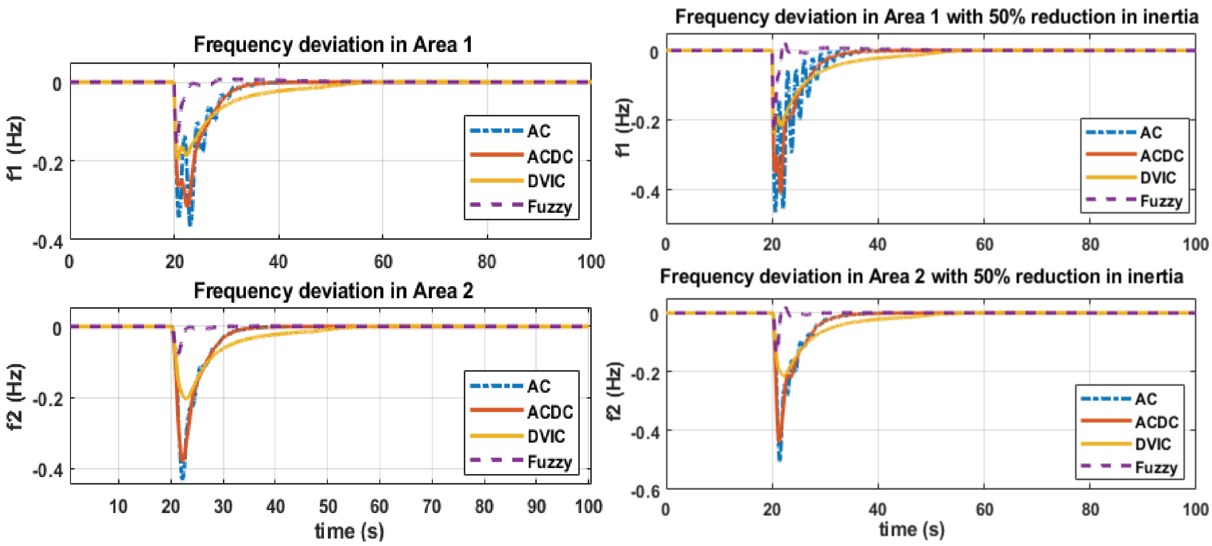

Fig. 4. Frequency deviation plot. Fig. 5 Frequency deviation plot with 50% reduction in inertia

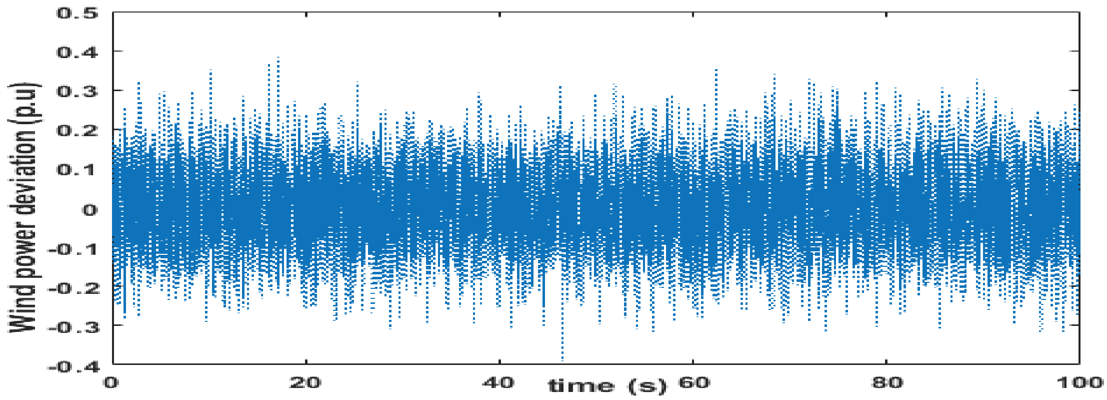

Fig. 6 Wind power intermittency

To analyses the effect of intermittency associated with renewable energy systems, a variation in wind power as shown in Fig. 6 is simulated in Area 1. This intermittency is simulated in parallel with the step load increase described previously It is that the continuous variation in wind power affect the frequency of the system continuously. Once again, the fuzzy logic virtual inertia controller provides best performance under this intermittent condition with reduced frequency deviation and effective zero-reference tracking of frequency in both areas.

Future scope: In Future work by using neuro fuzzy logic and support vector machine I will study the effect of inertia in the system, the inertia constant of the system is reduced by some percentage and load perturbation is simulated to observe the frequency response of the system. I will also study the response of reduction in system inertia with frequency deviation. The effectiveness of the ESS with fuzzy logic control and support vector machine is observed with least frequency deviation, fastest response time and shortest time to reach steady state.

CONCLUSION

In modern power systems with increased integration of renewable energy sources and dynamic system disturbance, it necessary to maintain the system stability. In this paper, a fuzzy logic controller integrated to an energy storage system has been used to provide virtual inertia to the system for power-frequency stability. The designed controller responds faster than the conventional derivative controller. Also, the advantage of HVDC links in parallel with ac tie-lines for interconnected power system has been demonstrated.

REFERENCES

[1] A. Ibrahim, P. Kumar, and S. Khatoon, "Overview of power system operational and control philosophies," International Journal of Power and Energy Systems, Review vol. 26, no. 1, pp. 1-11, 2006.

[2] A. Ibraheem and P. Kumar, "Study of dynamic performance of power systems with asynchronous tie-lines considering parameter uncertainties," Journal of the Institution of Engineers (India): Electrical Engineering Division, Article vol. 85, no. 1, pp. 35-42, 2004.

[3] A. Ibrahim, P. Kumar, and S. Ahmad, "Dynamic performance enhancement of hydro-power systems with asynchronous tie-lines," Journal of the Institution of Engineers (India): Electrical Engineering Division, Article vol. 85, no. 1, pp. 23-24, 2004.

[4] A. Ibrahim, P. Kumar, and S. Khatoon, "Effect of parameter uncertainties on dynamic performance of an interconnected power system incorporating AC/DC links," Internatinal Journal of Power Energy Systems, vol. 25, no. 3, pp. 198-210, 2005.

[5] E. Restani and P. Rodriguez, "Active power and frequency control considering large-scale RES," in Large Scale Renewable Power Generation: Advances in Technologies for Generation, Transmission and Storage, J. Hossain and A. Mahmud, Eds. Singapore: Springer Singapore, 2014, pp. 233-271.

[6] M. Dreidy, H. Mokhlis, and S. Mekhilef, "Inertia response and frequency control techniques for renewable energy sources: A review," Renew. and Sust. Energy Reviews, vol. 69, pp. 144-155, 2017.

[7] E. Rakhshani and P. Rodriguez, "Inertia emulation in AC/DC interconnected power systems using derivative

technique considering frequency measurement effects," IEEE Transactions on Power Systems, vol. 32, no. 5, pp. 3338-3351, 2017.

[8] Y. Han, P. M. Young, A. Jain, and D. Zimmerle, "Robust control for microgrid frequency deviation reduction with attached storage system," IEEE Trans. on Smart Grid, vol. 6, no. 2, pp. 557-565, 2015.

[9] T. Inoue and H. Amano, "A thermal power plant model for dynamic simulation of load frequency control," in IEEE PES Power Systems Conference and Exposition, 2006, pp. 1442-1447: IEEE.

[10] A. Fathi, Q. Shafiee, and H. Bevrani, "Robust frequency control of microgrids using an extended virtual synchronous generator," IEEE Transactions on Power Systems, vol. 33, no. 6, pp. 6289-6297, 2018.

[11] M. S. Mahmoud, N. M. Alyazidi, and M. I. Abouheaf, "Adaptive intelligent techniques for microgrid control systems: A survey," Int. J. of Electrical Power & Energy Systems, vol. 90, pp. 292-305, 2017.

[12] H. Bevrani, Robust power system frequency control, Second ed. Switzerland: Springer, 2014.

[13] T. Kerdphol, F. S. Rahman, Y. Mitani, M. Watanabe, and S. Küfeoğlu, "Robust virtual inertia control of an islanded microgrid considering high penetration of renewable energy," IEEE Access, vol. 6, pp. 625- 636, 2018.

[14] T. Kerdphol, F. Rahman, and Y. Mitani, "Virtual inertia control application to enhance frequency stability of interconnected power systems with high renewable energy penetration," Energies, vol. 11, no. 4, p. 981, 2018.

[15] T. Bhatti, Ibraheem, and Nizamuddin, "AGC of two area power system interconnected by AC/DC links with diverse sources in each area," Int.J. of Electrical Power & Energy Systems, vol. 55, pp. 297-304, 2014.

[16] T. Kerdphol, F. Rahman, Y. Mitani, K. Hongesombut, and S. Küfeoğlu, "Virtual inertia control-based model predictive control for microgrid frequency stabilization considering high renewable energy integration," Sustainability, vol. 9, no. 5, p. 773, 2017.

[17] Y. Karnavas and D. Papadopoulos, "AGC for autonomous power system using combined intelligent techniques," Electric power systems research, vol. 62, pp. 225-239, 2002.

[18] Y. Hu, W. Wei, Y. Peng, and J. Lei, "Fuzzy virtual inertia control for virtual synchronous generator," in 35th IEEE Chinese Control Conference (CCC), 2016, pp. 8523-8528.