# Neural Network Based Transient Stability Assessment

Mr. AvinashDevidasGadkari, Dept. of Electrical & Electronics Engineering
Rabindranath Tagore University, Bhopal

Abstract

The adverse effect of fluctuation especially case of three-phase fault on power system network is very severe. So it is important to determine the characteristic behavior of these networks so that when the fault occurswe are capable in maintaining or avoid the impact of these fluctuations on the power system network. The objective of this research is evaluation of the critical clearing time and the rotor angle by which the circuit breaker(s) need to open during these abnormal conditions without damaging the generators under synchronism, etc. First the test system 132KV sub-transmission network were modeled using ETAP 7.0 Software for doing time domain simulation process and obtain results for further analysis. Then in MATLAB environment, program using Runge-Kutta (order-2) method was used for solving the swing equation of SEMIB for further data collection. And at last the selected features from Runge-Kutta's method's results were fed into the feed-forward neural network (FFNN), later on the inputs and targets/outputs were mapped out and CCT required for the operation of the circuit breakers is computed. Thus, from the comparative results of the (FFNN) and the conventional (R-K) method shows that both can be complementary to evaluate the CCT and rotor angle for transient stability assessment of power system networks.

Key Words

Critical clearing time, ETAP software, MATLAB, FFNN, Power system networks, Transient stability, Torque angle, etc.

## Introduction

The increasing demand and needs for electric power, networking for consumption on daily basis is neverending. The electric power network is extremely complex; bulk electric power is transmitted over the interconnected networks of transmission lines linking generators, power transformers, loads, etc. Successful operation of a power system depends largely on the ability to readily provide reliable and uninterrupted service delivery to the loads. Constant voltage and frequency at all times is required by consumer's equipment to proper operation. Usually, in a power generating station two or more generators work in synchronism for providing bulk electric power through transmission networks. The evaluation of effect on performance of these synchronous machines after being disturbed is very important for stability of the power system. It is noted that in power system stability studies especially during the transient events: the rotor angle, power transfer capabilities, frequency, and voltage, etc., are fundamental electrical variables that change. Transient stability is a function of abnormality in power system that required immediate normalcy. And it is the ability of an electric power system to keep its synchronous machines in synchronism when subjected to large or small disturbance. In this paper, we utilize the advantage of applying feed-forward neural network, a class of ANN in assessing the critical clearing time of appropriate circuit breaker in connection with generators lumped as Single Machine connected to Infinite Bus System as the main aim.

Result

From the different stages of assessment of the 132KV power system network operating at 132KV and 33KV. Table I shows the results of the respective percentage fault location of line 1 during the time domain simulation (TDS) of the transient stability assessment using ETAP Software

| Percentage Fault Location (%) | Three phase Fault Location From Afam bus to PH(Z 4)Bus (KM) | Equivalent Inertia Constant H (MJ/MVA) | Pmaxdf (During fault) (Pu) | $Pe_2$ (During fault) (Pu) | Critical Clearing Angle, dcrang (deg.) | Critical Clearing Time (CCT) (s) |
|---|---|---|---|---|---|---|
| 10 | 3.835 | 14.65 | 3.0111 | 2.9700 | 67.1 | 0.37 |
| 20 | 7.67 | 14.65 | 3.1444 | 3.1200 | 66.7 | 0.55 |
| 30 | 11.505 | 14.65 | 3.2417 | 3.2300 | 69.1 | 0.56 |
| 40 | 15.34 | 14.65 | 3.3126 | 3.3100 | 68.5 | 0.56 |
| 50 | 19.175 | 14.65 | 3.3809 | 3.3800 | 68.2 | 0.56 |
| 60 | 23.01 | 14.65 | 3.4249 | 3.4200 | 66.6 | 0.56 |
| 70 | 26.845 | 14.65 | 3.4627 | 3.4500 | 66.7 | 0.56 |
| 80 | 30.68 | 14.65 | 3.3927 | 3.3800 | 66.7 | 0.56 |
| 90 | 34.515 | 14.65 | 3.5244 | 3.4900 | 66.6 | 0.56 |
| 100 | 38.35 | 14.65 | 3.5252 | 3.4900 | 66.6 | 0.56 |

Table 1

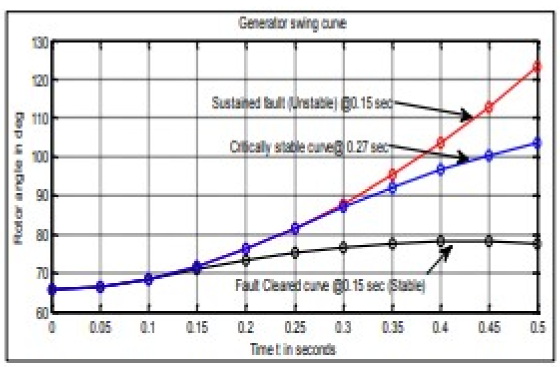


Figure 1 Graph of swing curve for 10% fault location on line 1

Conclusion

The assessment was performed at three distinct steps. From the results obtained, it is found that the network attained stability very fast the fault was cleared by opening of the circuit breaker and the maximum Critical Fault Clearing Time realized was 0.56s. On further numerical analysis for solving the SEMIB swing equation, RungeKutta method was performed using MATLAB. Later the results obtained were feds into FFNN for further matching the selected inputs and targets to output the CCT required. The aim of evaluating the critical clearing time and the angle has been achieved. From the results CCT increases with a corresponding increase in the angle of swing during a fault condition. It is evident that the power delivered during this fault condition also increases slightly corresponding to either maximum clearing angle (δmax) or the critical clearing angle (δcrang) as a result of transient current. In general, the test network is able to return to its normal operating condition. The importance of estimating the critical fault clearing time is to protect and prevent damage to apparatus as the circuit breaker is opened. For rapid fault clearing, using high-speed circuit breakers quick restoration will be achieved is better for operation.

Reference

1. R. B. Epili, and K. Vadirajacharya, "Performance analysis of transient stability on a power system network," International Journal of Advanced Research in Electrical and Electronics Engineering, vol. 2, no. 2, pp.37-44, 2014.
2. D. P .Kothari, and I. J. Nagrath, "Modern power system analysis, power system stability," 4th ed., New Delhi: Tata McGraw-Hill Education Private Limited, 2013, pp.426-485.
3. A. Karami, "Power system transient stability margin estimation using neural networks," Electrical Power and Energy Systems, vol.33, pp.983-991, 2011.
4. S. Orike, "Computational intelligence in electrical power systems: a survey of emerging approaches," British Journal of Science, vol.12, no. 2, pp. 23-45, 2015.
5. L. Potheamsetty, S. Ranjan, M. K. Kirar, and G. Agnihotri, "Power system transient stability margin estimation using artificial neural networks," Electrical and Electronic Engineering: An International Journal, vol. 3, no.4, pp.47-56, 2014.
6. N.I. Abdulwahab, A. Mohamed, and A. Hussain, "Transient stability assessment using PNN and LS-SVM methods," Journal of Applied Sciences,vol.7,no.21,pp.3208-3216,2007.
7. N. Amjady, and S.F. Majedi, "Transient stability prediction by a hybrid intelligent system," IEEE Trans. On Power Systems, vol. 22, no. 3, 2007, pp.1275-1283.
8. P. K. Olulope, K. A. Folly, S. Chowdhury, and S.P. Chowdhury, "Transient stability assessment using artificial neural network considering fault location," Iraq J. Electrical and Electronic, vol.6. no.1, 2010, pp.67-72.
9. S. Kalyani, and K. Shanti Swarup, "Study of neural network models for security assessment in power systems," International Journal of Research and Reviews in Applied Sciences, vol.1, no.2, pp.104-117, 2009.
10. Wang Li, Quang-Son V. "Power flow control and stability improvement of connecting an offshore wind farm to a one-machine infinite-bus system using a static synchronous series compensator", IEEE Trans Sust Energy vol. 4(2)2013