BLACKOUT INTERFERENCE ON POWER INJECTION INFORMATION IN MULTIMACHINE REAL TIME MONITORING SYSTEM

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ABSTRACT

The oscillation control based on power system as an information data real time that replace the conventional automatic voltage regulators for excitation control additional in a multimachine power system is presented in this research. The design is based on equilibrium and decreasing time oscillation each generator, a powerful adaptive critic technique adequate on transfer system of data on all instruments. The feedback variables are completely based on locally measurements from the generators. Simulation on multi machine power system was demonstrated using application software for improving dynamic performance and stability of the power grid under large disturbances that influenced oscillation power station and missing on data resources.

Keywords: ESS, Multimachine, Oscillation, EDSA

INTRODUCTION

Power systems containing generators are large scale nonlinear systems. The traditional excitation controllers for the generators are designed by linear control theory based on a single machine infinite bus (SMIB) power system model. This can occur in emergencies such as power system restoration, or dividing the power system into small islanding systems. In the case of large interconnected power systems, all generating units operating as frequency regulators will contribute to the overall change in generation irrespective of the location of the load change. In the case of small, isolated load operation the unit must hold the system frequency constant. This is an important distinction because the criteria for system stability differ from those for an unit connected to a large power system. This will allow an understanding of the dynamics of the generator for different loading conditions.

In recent years, renewed interest has been shown in power systems control using nonlinear control theory as the analyzed method, particularly to improve system transient stability. Instead of using an approximate linear model, as in the design of the conventional power system stabilizer, nonlinear models are used and nonlinear feedback linearization techniques are employed for the generator models, thereby alleviating the operating point dependent nature of the linear designs. Using nonlinear controllers, generator transient stability can be improved significantly. However, nonlinear controllers have a more complicated structure and are difficult to implement relative to linear controllers.

MULTISYSTEM DATA MAP MODELING

Generator Modeling

The dynamic behavior of the generators within a power system is of fundamental importance to the overall quality of the power supply. The synchronous generator converts mechanical power to electrical power at a specific voltage and frequency. The source of the mechanical

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power, the prime mover, may be a diesel engine, a steam turbine or a water turbine. Whatever the source, it must have the basic property that its speed is almost constant regardless of the power demand. The analysis of any power system to determine its transient stability involves the mechanical properties of the machines because, after any disturbance, they must adjust the angle of their rotors to meet the conditions of power transfer imposed. The electric dynamics have very short time constant compared to hydrodynamics and can be ignored.

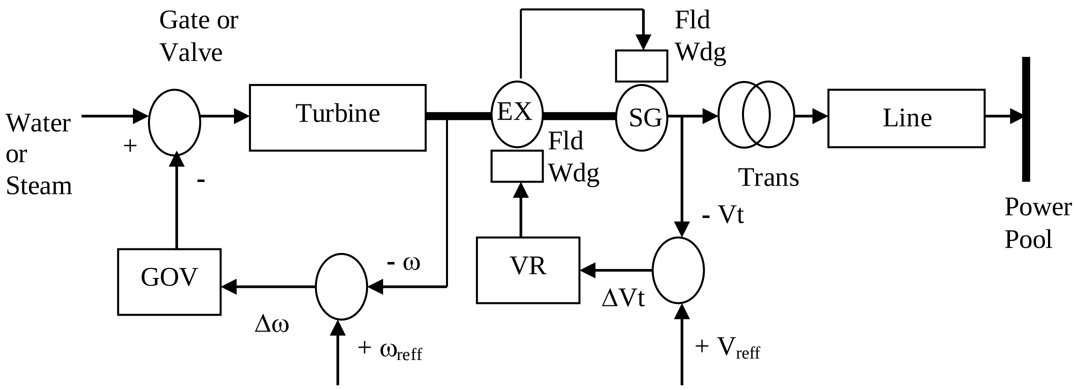

Figure 1. Power system components

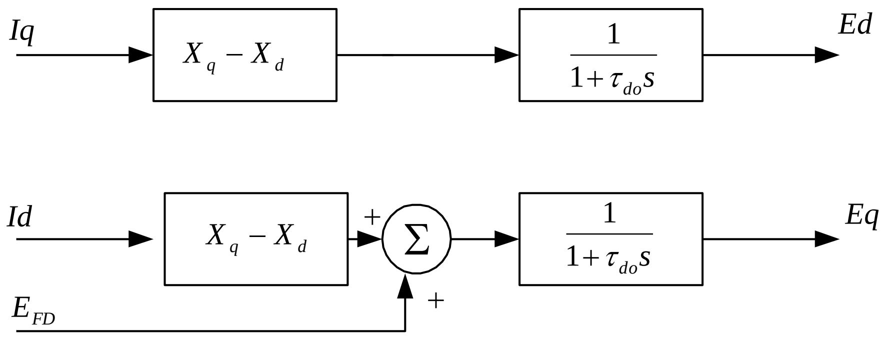

Figure 2. Generator model

The mechanical equations of a rotating machine are very well established and they are based on the swing equation of the rotating inertia. For the purpose of control analysis, the generating unit is modeled by linear differential equations, which describe their response to small perturbations. The swing equation relates the machine's rotor torque angle to the acceleration torque, which is the difference between the shaft torque and electromagnetic torque. Constant shaft speed for a given machine is maintained when there is equilibrium between the mechanical shaft and braking electrical torques. Any imbalance between the torques will cause the acceleration or deceleration of the machine according to the laws of motion of a rotating body.

$$J.\frac{d^2\theta_m}{d^2t} = T_m - T_e \quad \text{.......................................(1)}$$

$$J.\omega_m.\frac{d^2\delta}{d^2t} = P_m - P_e \quad \text{.......................................(2)}$$

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$$M.\frac{d^2\delta_m}{d^2t} = P_m - P_e \quad \text{.....(3)}$$

Several models that it which have been used in modeling synchronous machines for stability studies, some including damper windings and transient flux linkages, some neglecting them. A two-axis model that includes one damper winding in the d-axis (direct axis) and two in the q-axis (quadrature axis) along with the transient and sub-transient characteristics of the machine. This model will be discussed here and involves the transformation of the machine variables to a common rotor based reference frame through the Park's transformation. This transformation changes a reference frame fixed with the stator to a rotating reference frame fixed with respect to the rotor, namely the direct axis (d-axis), the quadrature axis (q-axis) and a third axis associated with the zero sequence component current (0-axis). Eventually, the latter is dropped from the model due the fact that the zero sequence current is equal to zero for a balanced system.

$$\tau'_{q0}\,\dot{E}'_d = -E'_d - (xq - xq')Iq \quad \text{.....(4)}$$

$$\tau'_{d0}\,\dot{E}'_q = E_{FD} - E'_q + (xq - xq')Id \quad \text{.....(5)}$$

Load Modeling

The term load can be defined as a device connected to a power system (bus) that consumes reactive or active power. Load modelling is qualitatively different from generator modelling. It is relatively simple to construct models of any of the typical load component such as lamps, heaters, and refrigerators. However, this is only a small part of the problem because the exact composition of the load is often very difficult to estimate. Load composition changes continuously reflecting customer patterns of using various appliances and devices. It depends on weather, consumer life style and many other factors. Even if the load composition were known exactly, it would be impractical to represent each individual load component.

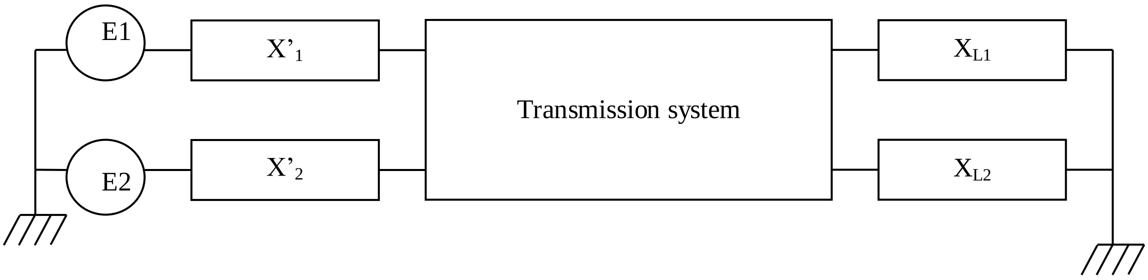

Figure 3. Multi machines system

In power system stability, the common practice is to represent the composite load characteristic as seen from bulk power delivery points. The aggregated load is categorized into load classes and each category is represented in terms of load component. Historically, load characteristics are divided into two categories static and dynamic.

A static model expresses the active and reactive powers as functions of the bus voltage and frequency at any instant of time. It is common to represent the load by separately considering the active power (P) and reactive power (Q); both can be represented by a combination of constant impedance, current and power elements. The representation is based on the frequency and voltage dependence of the load observed over a rather limited range of variation and often is based only on the measured slopes (dP/df) and (dQ/df). Representation of multi machines system can be shown with:

$$Y_L = \frac{P_L - jQ_L}{|V|^2} \quad \text{.......}(6)$$

$$Y_{rel} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \quad \text{.......}(7)$$

$$P_k - j.Q_k = V_k . \sum_{n=1}^{N} Y_{kn} . V_n \quad \text{.......}(8)$$

Excitation System Models

Two different types of exciters (AVRs) were used for the system generators. For the machines without ESSs, a simple gain exciter was employed. For this model, the control equation is written as EFD. The parameters for the simple gain model, for the machines with a ESS, the IEEE ST1 Type exciter.

$$\dot{V}_{R\Delta} = \frac{1}{\tau_R} V_{T\Delta} - \frac{1}{\tau_R} V_{R\Delta} \quad \text{.......}(9)$$

$$\dot{V}_{F\Delta} = \frac{K_F}{\tau_F} E_{fd\Delta} - \frac{1}{\tau_F} V_{F\Delta} \quad \text{.......}(10)$$

$$\dot{V}_{A\Delta} = \frac{K_A}{\tau_A} (V_{REF\Delta} - V_{F\Delta}) - \frac{1}{\tau_A} V_{A\Delta} \quad \text{.......}(11)$$

$$\dot{E}_{fd\Delta} = \frac{1}{\tau_E} V_{A\Delta} - \frac{K_E}{\tau_E} E_{fd\Delta} \quad \text{.......}(12)$$

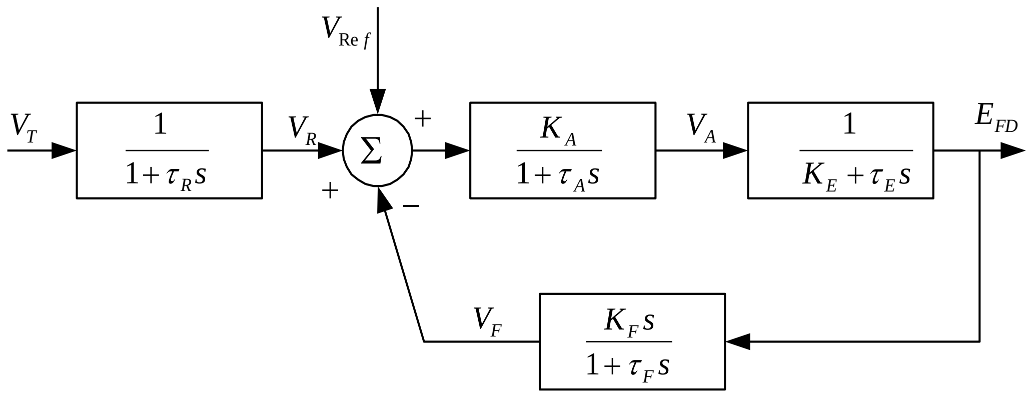

Figure 4. Excitation model

METHOD & SIMULATION

The research was simulated for evaluation the existing system on 150 kV in Malang with condition blackout as the large disturbance in Malang till loss of information on system communication transfer. It could done by branch tripping on south tail in Kebon Agung, that would be disinter connected to Tulung Agung and Blitar. At north side was given by branch tripping in Lawang to opening the interconnection to Pasuruan. Power system in Malang has interconnected to Region 4 of PLN in Pasuruan, it was also exported to Tulung Agung through Blitar.

Simulation was done with load condition on 150 kV power line, peak load on Region 4 are 3.178,01 MW and 1.163,441 Mvar, with exploring in Madura 109,11 MW and 42,9 Mvar, Bali 336,3 MW and 118,8 Mvar, East Java 2.732,6 MW and 1.001,741 Mvar.

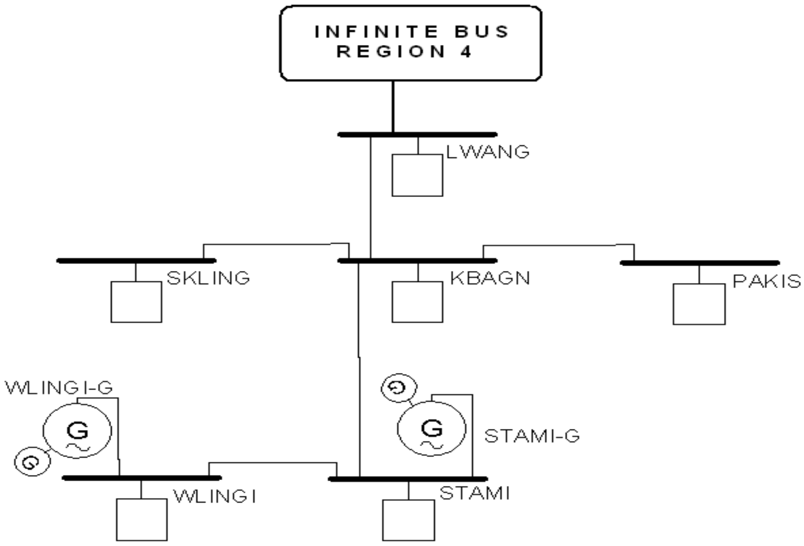

Figure 5. Power system in Malang

In Malang the power system was viewed on 150 kV, because it didn't have power line system on 500 kV, and supplying to 70 kV with under its voltage system eliminate to system 150 kV with considering all the interconnection system. Peak load was in Lawang 16,800 MW and 7,000 Mvar, Kebon Agung 115,000 MW and 60,000 Mvar, Pakis 30,500 MW and 16,900 Mvar, Sengkaling 58,700 MW and 34,200 Mvar, so Wlingi 58,900 MW and 38,500 Mvar.

Table 1. Peak load in Malang

No	*Bus*	*Peak load*	
		MW	*Mvar*
1	Kebon Agung	115,000	60,000
2	Lawang	16,800	7,000
3	Pakis	30,500	16,900
4	Sengkaling	58,700	34,200
5	Sutami	0,000	0,000
6	Wlingi	58,900	38,500

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Table 2. Power line impedance in Malang

No	From	To	Length (m)	Cir	Per KM		
					R (ohm)	X (ohm)	B/2 (pu)
1	INFINITE BUS	LWANG	34680	1	0,06336	0,08692	0,0000103
2	KBAGN	PAKIS	12900	2	0,04739	0,04429	0,0000230
3	KBAGN	STAMI	27950	2	0,03168	0,04346	0,0000244
4	LWANG	KBAGN	25805	2	0,03168	0,04346	0,0000210
5	SKLING	KBAGN	15100	2	0,03819	0,04346	0,0000169
6	STAMI-G	STAMI	25	1	0,08642	0,08083	0,0000000
7	WLINGI	STAMI	21600	1	0,08642	0,08083	0,0000330
8	WLINGI-G	WLINGI	25	1	0,08642	0,08083	0,0000000

RESULT AND DISCUSS

Power Flow

To prepare the system data for a stability study, load flow studies are done. These studies establish the operating point about which the nonlinear differential equations are linearized. A power flow program or load flow finds the steady state voltage and angle at each bus for a given system. Conventional nodal or loop analysis is not suitable for power flow studies because the input data for loads are normally given in terms of power. Also, generators are considered as power sources, not voltage or current sources. The power flow problem is therefore formulated as a set of non-linear algebraic equations suitable for computer solution.

Table 3. Power flow each line

No	Location		kV Drop (%)	Send from		Losses	
	1	2		1	2	(KW)	(Kvar)
	From	To		(MW)	(Mvar)		
1	INFINITE BUS	LWANG	1,71	95,566	53,791	1252,4	1291,4
2	KBAGN	PAKIS	0,13	30,537	16,015	36,7	-885,0
3	KBAGN	STAMI	0,53	-80,133	-35,432	337,8	-519,1
4	LWANG	KBAGN	0,87	125,089	74,580	852,4	320,9
5	SKLING	KBAGN	0,26	-58,700	-34,200	132,9	-523,5
6	STAMI-G	STAMI	0,06	105,000	45,600	55,8	52,2
7	WLINGI	STAMI	0,30	-23,908	-11,908	64,7	-1273,0
8	WLINGI-G	WLINGI	0,02	35,000	26,600	8,3	7,8

The information obtained from a power flow study is essential for the continuous monitoring of the current state of the system and for analyzing the effectiveness of alternative plans for the future, such as adding new generator sites, meeting increased load demands, and locating

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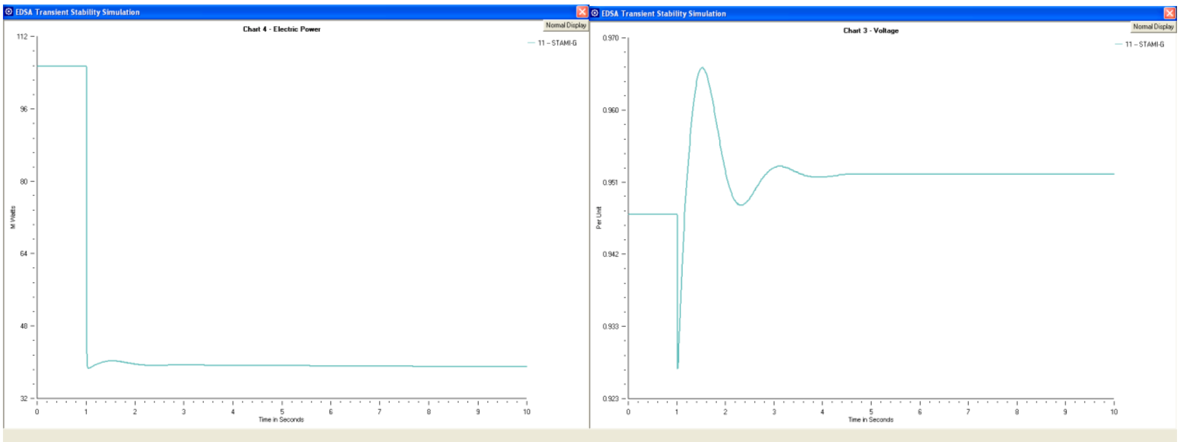
new transmission sites and also essential for establishing initial conditions for stability studies. The algorithm presented here uses the Newton Raphson method for finding solutions for the variables such as voltage magnitudes and their angles at all buses. Load flow or power flow was analyzed with Newton Raphson, it resulted to know the flow on every power line supplying demand and voltage on each bus. Load flow of power system in Malang has highest voltage drop in Lawang, that was 1,71 %. And the highest losses on infinite bus Lawang, that was 1.252,4 KW.

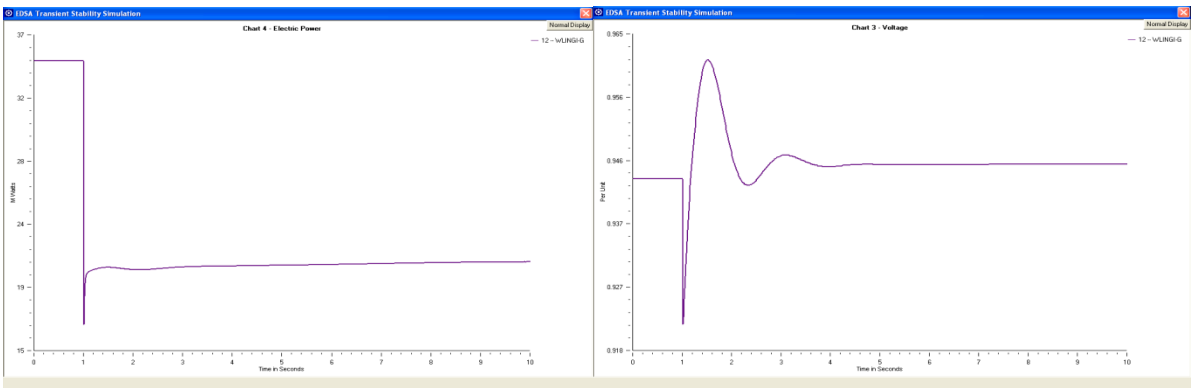
Generator Response on Information Varying Data Map

The results have shown that at operating conditions different from the one at which the AVRs were tuned, their performances have degraded. Large disturbances were carried out at different power levels and power factors to confirm this. An ESS on excitation system has been well rewarded by allowing significant increases in power transfer limits over restricted transmission facilities over on branch tripping. This heavy reliance on ESS has meant that the part has devoted considerable efforts to the improvements of these devices, culminating in the widespread application of the stabilizer with its built in self-monitoring.

Operating security limits are based on simulations using standard representations for all of the system components. If the ESS is excessively complex it will have to be approximated in the simulations, in which case any benefits may not be reflected in the derived operating security limits. When some disturbances being any place, so all the power station would response it, such as on this case by branch tripping on feeder that reacted on Sutami and Wlingi as both the hydro power station



a. Electric power and voltage respond of Sutami power station



b. Electric power and voltage respond of Wlingi power station

Figure 6. Power station respond

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On figure 6 is shown generator response of Sutami power station when blackout condition there. It viewed that generator have oscillation on electric power and voltage, so it changed on supplying power. Overshoot of voltage 0,968 pu at 0,8 second after branch tripping faulted, the increasing voltage as the effect on load lost was 0,948 rise to 0,952 pu on 150 kV. But at the Wlingi Power station only 0,944 pu rise to 0,946 pu, with overshoot 0,962 at 0,53 second after faulted blackout.

CONCLUSION

According to the result shown that voltage drop is highest on Lawang bus, that was 1,71 %. Highest losses 1.252,4 KW on feeder infinite Bus to Lawang bus, and the blackout condition would disturb each power station on oscillation response. Each power station have stated an instability condition to regain new point.

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