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On Line Application Simulink Model For Transient Stability Analysis Of The Blackouts System

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Abstract—**The study of multi-machine transient stability in a large interconnected power system requires a lot of computational time. To reduce the computational time, a model of real-time of transient stability simulation method is employed in power systems. Application in transient stability provides very quick insight into the behavior of the generators under a three-phase fault. The objective of this paper is accelerating computation time. The requirement is a computationally efficient way of processing on line to determine whether an evolving event will ultimately be stable or unstable. The proposed optimal power flow on transient stability model will be tested and analyzed using an illustrative the IEEE Western System Coordinating Council (WSCC) 3-machines 9-bus test system.**

Keywords- on line; transient stability; model; blackouts

I. Introduction

Transient stability is the ability of the power system to maintain synchronism when subjected to a severe transient disturbance, such as a fault on transmission facilities, sudden loss of generation, or loss of a large load. The system response to such disturbances involves large excursions of generator rotor angles, power flows, bus voltages and other system variables. It is important that, while steady-state stability is a function only of operating conditions, transient stability is a function of both the operating conditions and the disturbance's.[1]

Dynamic power flow transients in the transmission network following a fault are in the order of a hundred milliseconds to several seconds. A short circuit fault in a transmission line will cause a sudden cut in electrical power output at each generation unit, resulting in an oscillation among internal generator angles. If the oscillation exceeds the critical angle difference, the generator step out will take place in a couple of second.[2]

Some European and Asian countries have illustrated the importance and requirement of quick study for power system stability, because of recent blackouts in the USA. [3]

Following events that have befallen in Western System Coordinating Council (WSCC):
1965 – November: Northeast blackout
1977 – July: New York City blackout
1994 – January: WSCC breakup
– December: WSCC breakup
1996 – July 2: WSCC cascading outage
- August10: WSCC cascading outage.
1998 – June: MAPP breakup
– December: San Francisco trip off
1999 – July: New York City (200,000 customers)
– July: Chicago (100,000 customers)
– August: Chicago (“Loop” business district)
2000 – May: PJM power voltage reductions and curtailments
–June: California outages and price increases

II. Modeling Case

A. Case Study

A transient stability analysis based on the popular western system coordinated council (WSCC) model will be described in Figure.1. The simulation results in this subsection are based on a system with 3 machine 9 buses, base MVA is 100 and system frequency is 60 Hz.[4]

The simulation and the MVA ratings are shown in the transmission lines and transformers below in figure 1, to indicate the normal operating limit for these components. This is also the system appearing in references. [5]

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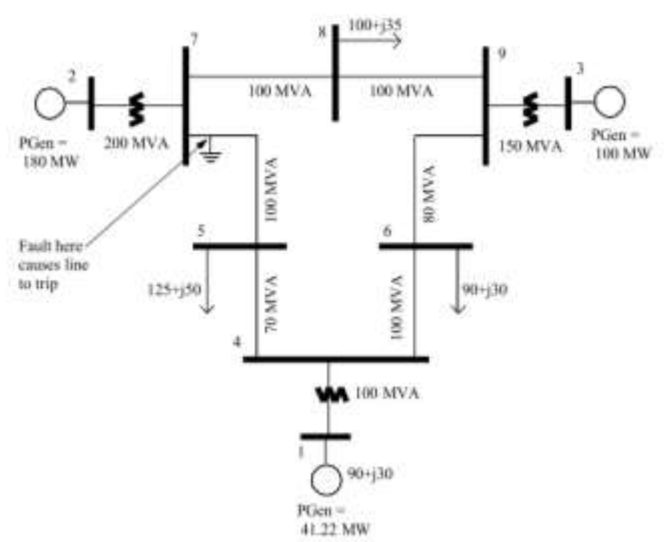


Figure.1. Single line diagram of WSCC 3-machines and 9-bus system.[4][5]

The well known WSCC 3-machine 9-bus power system, as shown above is considered in the present study. We treated Generator 1 of the three machine system as slack bus in the initialization since it had the largest inertia.[6][7]

B. Simulink Models

A complete model for transient stability of a multi-machine power system was developed using simulink. A Simulink model is very user friendly. Typically, for a transient stability study the model facilitates fast and precise solution of nonlinear differential equations viz. the swing equation.
Simulink is an interactive environment for modeling, analyzing and simulating a wide variety of dynamic systems. Simulink provides a graphical user interface for constructing block diagram models using 'drag and drop' operations. Simulink is particularly useful for studying the effects of non-linearity on the behavior of the system and as such, is also an ideal research tool.[4] Through the use of scopes and plots the package has exhibited quite interesting capabilities : it has allowed clear observation as to how the system stability and the severity and mode of unstable.
The typical parameter values are given in reference [1]. These values can be either defined in m-file program or can be directly supplied to the simulink models.

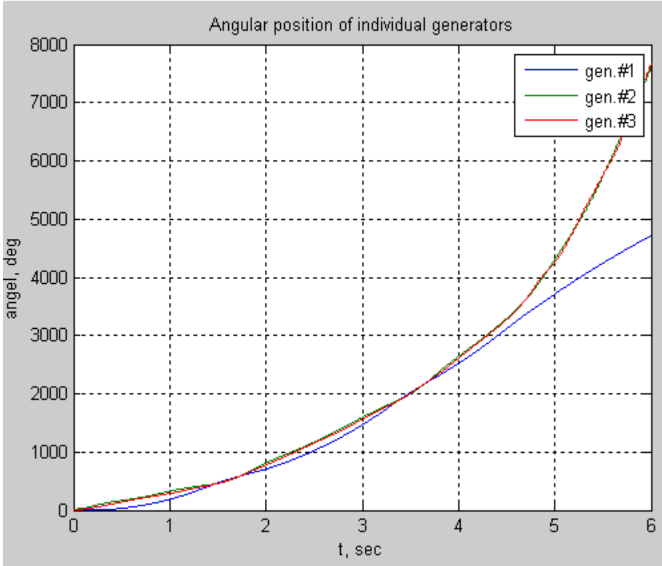
C. Algorithm

We can have the general algorithm for the objective of this paper is that the resulted power flow will be trained on transient stability model on-line application in below.

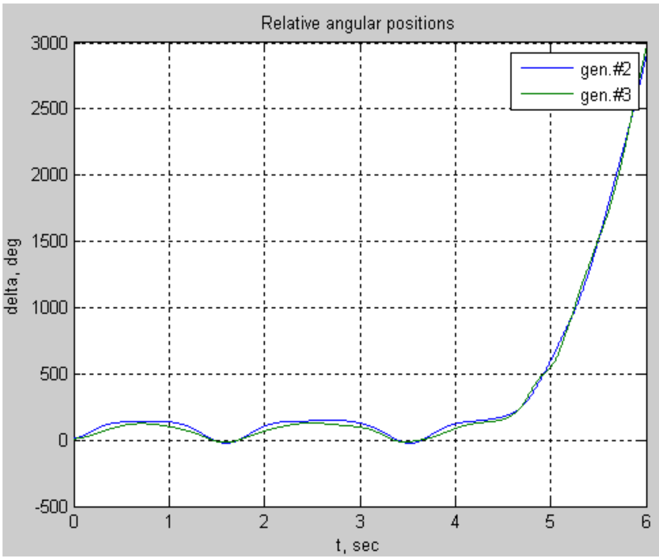
Converting the whole time-domain simulation of the system transient by simulink model may require prohibitive computing time and prohibitive memory size, and may lead to convergence issues.[8]

III. Simulation Results

The system responses are given for different values of critical clearing time (CCT). Figure's 2(a) and (b) show the individual generator angles and difference angles (with generator 1 as reference) for the system with CCT = 0.1606 s, whereas Figure's 2(c) and (d) show the rotor angular speed deviations and accelerating powers for the same case. In this case, the results shows that the power system is stable.



(a). Angular position of individual generators



(b). Relative angular δ21 and δ31.

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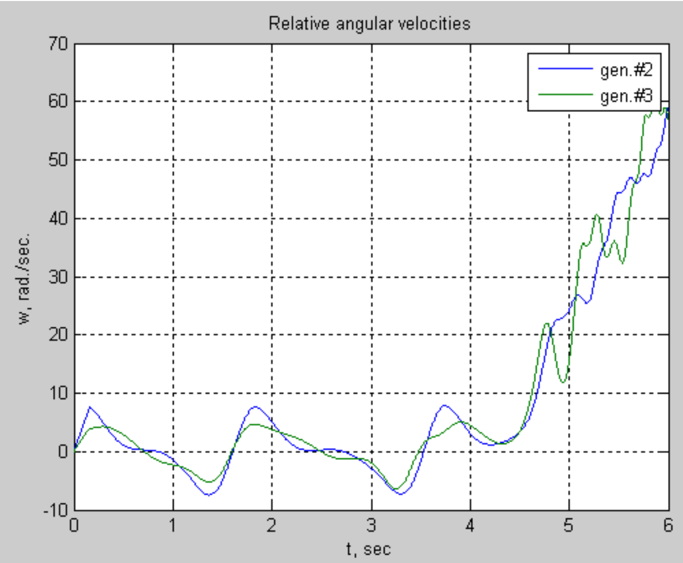
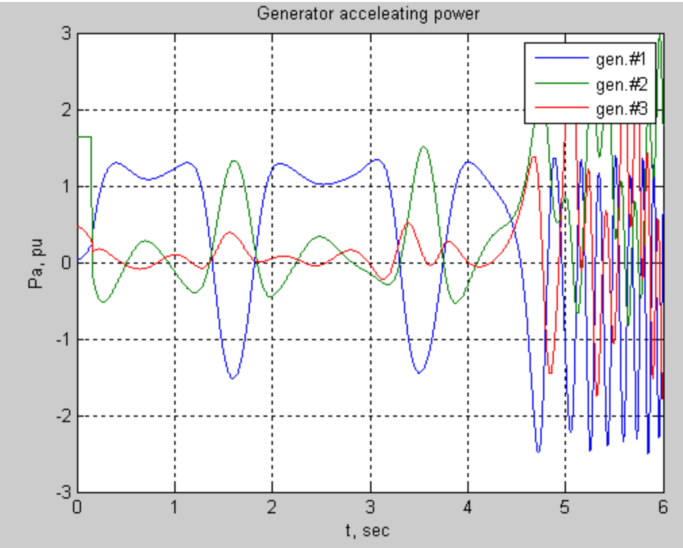


(c). Relative angular velocities

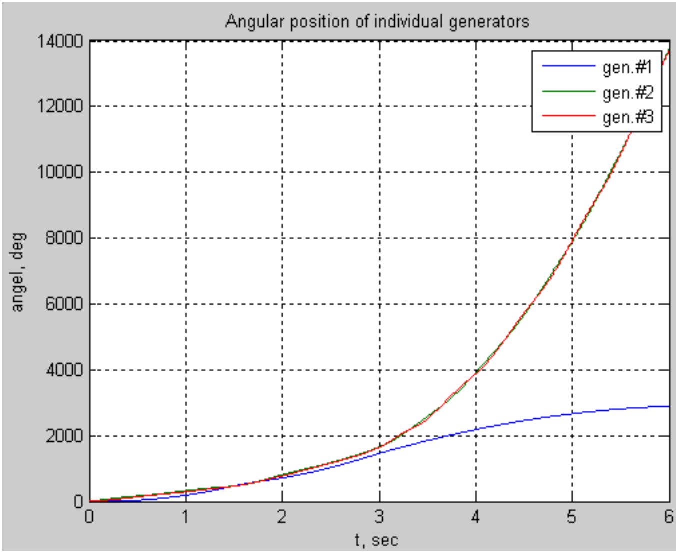


(d). Generator accelerating powers.

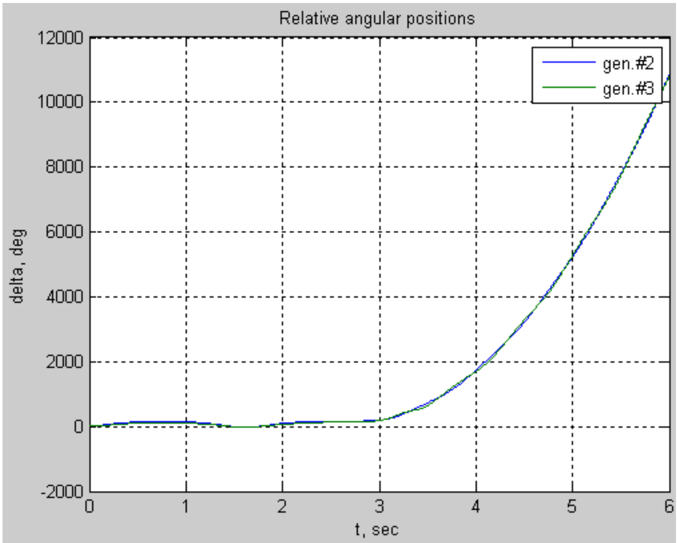
Figure. 2. System responses without damping for CCT = 0.1606.

We can see in the complete model of figure 5. that output ports 7, 8 and 9 give the individual generator angles of the respective machine. Ports 10 and 11 (or alternatively scopes 4 and 5) give the relative angular positions of generator 2 and 3 respectively, with generator 1 as reference. Similarly, port 4,5 and 6 give the angular velocities of the machine, whereas scopes 1-3 (or the corresponding ports) display the accelerating powers. At this point the system is critical stable.

Figure 3(a), (b), (c) and (d) show the system responses for a CCT unstable value. At this point the system unstable for CCT = 0.1607 s.[4]



(a). Angular position of individual generators



(b). Relative angular $\delta 21$ and $\delta 31$

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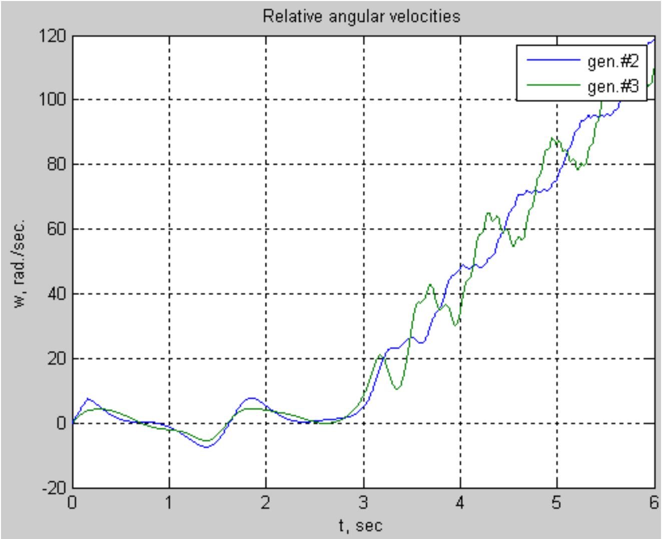
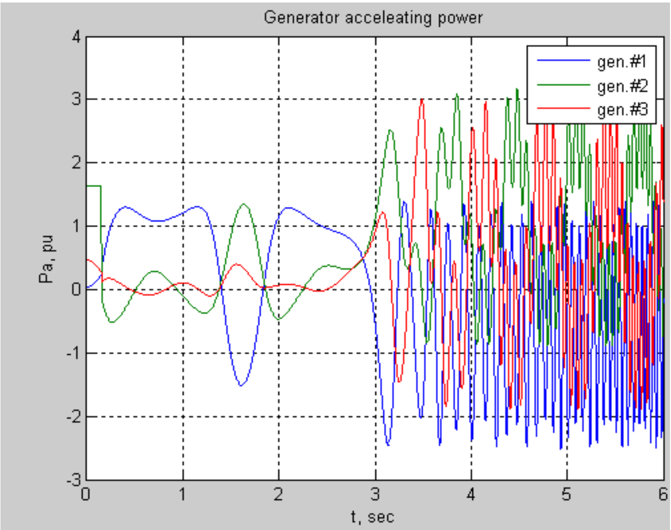


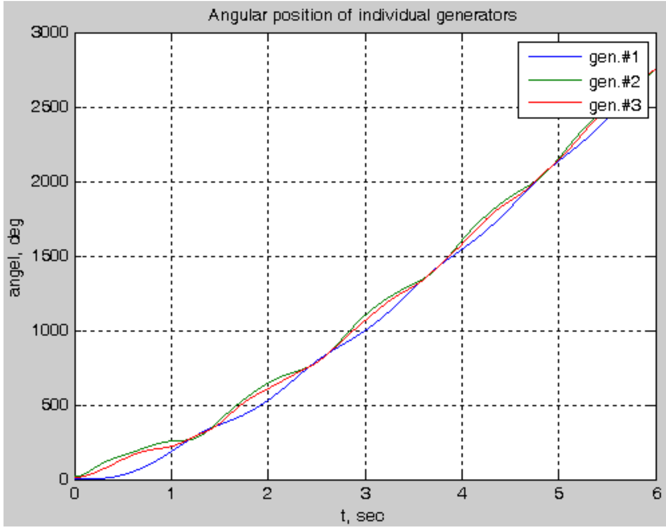
(c). Relative angular velocities



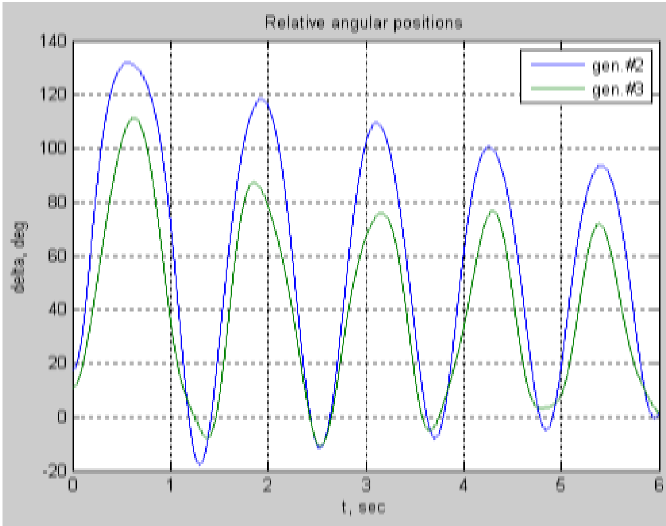
(d). Generator accelerating powers

Figure. 3. System responses without damping for CCT = 0.1607.

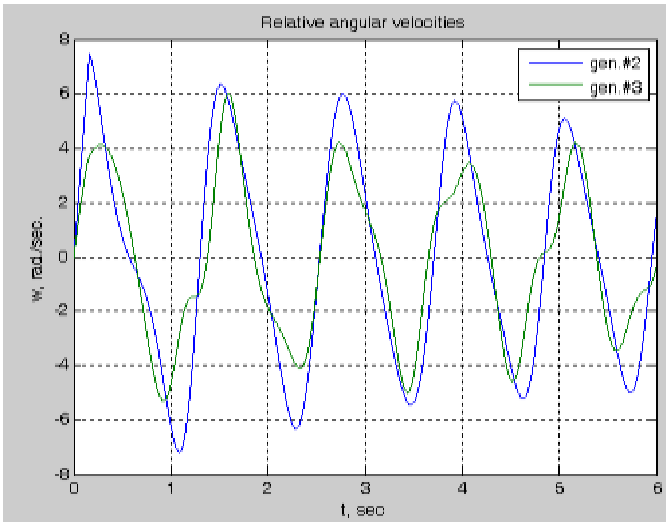
It is clear from the above Figure. 3. that, the most severe situation in terms of minimum critical clearing time CCT as obtained by the System responses without damping at the point the system after 3 second will be unstable.



(a). Angular position of individual generators



(b). Relative angular δ21 and δ31



(c). Relative angular velocities

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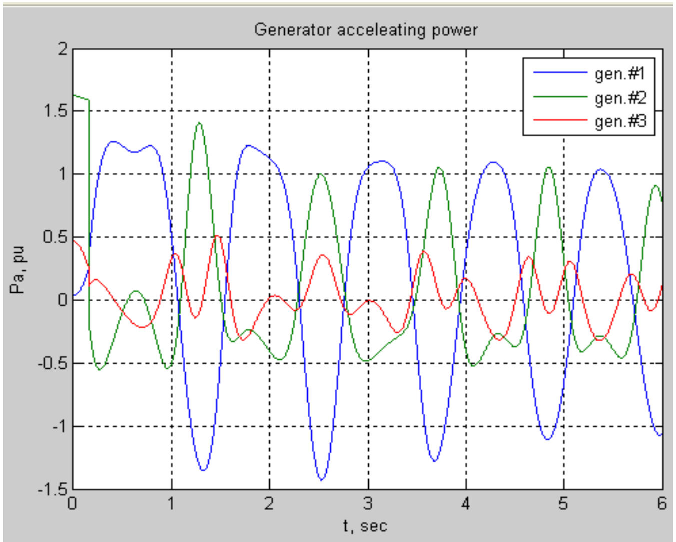

(d). Generator accelerating powers

Figure. 4. System responses with damping = 0.1661 for CCT = 0.1607.

In Figure 4. shows that during the critical clearing time the system is still in stable condition for 3 second.
In Figure 4.(a), values of angles are plotted. It is clear that all the angles of the generators are increasing and that they swing almost together.
In Figure 4.(b), the angles of generator 2 and 3 are plotted with reference to the angle of generator 1, where the relative angle displacement with respect to generator 1 is shown. However, plotting angle displacement relative to a generator and observing it from the relative angles in synchronism is not a confirmed test of stability. This is because it may happen that generator 1 is not in synchronism with respect to generator 2 and 3. However since generators 2 and 3 are almost in synchronism with respect to each other, a plot of their relative angles with respect to generator 1 will also show synchronism.
The plot for speed of the machine is shown in Figure 4.(c). It can be seen that the speed become weakened after crossing the zero axis
The accelerating power (P_a) is shown in Figure 4.(d).

IV. Conclusion

This paper presents modeling the parameters for transient stability improvement of a multi-machine power system.
The main contribution of this paper is to develop transient model on-line application on affective method for transient stability assessment.

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