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Effect of fault location on transient stability

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ABSTRACT

This paper shows an analysis of the effect of three phase to ground fault on the transient stability for the enhancement of power system using ETAP software, Transient stability is an important aspect in designing and upgrading electric power system after major failures cause by power system instability. The goal of transient stability analysis of power system is to analyze the stability of a power system in a time domain of a few seconds to few minutes using ETAP software.

Keywords : Transient stability Analysis, Time domain method, Fault location, Etap Software

I. INTRODUCTION

Successful operation of a power system depends on the engineer's ability to provide reliable and uninterrupted service to the loads. Power system stability is the ability of an electric power system, for a given initial operating Condition, to regain a state of operating equilibrium after being subjected to a physical Disturbance, with most of the system variables bounded so that practically the entire system remains intact.

The disturbances mentioned in the definition could be faults, load changes, generator outages, line outages, voltage collapse or some combination of these. Power system stability can be broadly classified into rotor angle, voltage and frequency stability. Each of these three stabilities can be further classified into large disturbance or small disturbance, short term or long term.

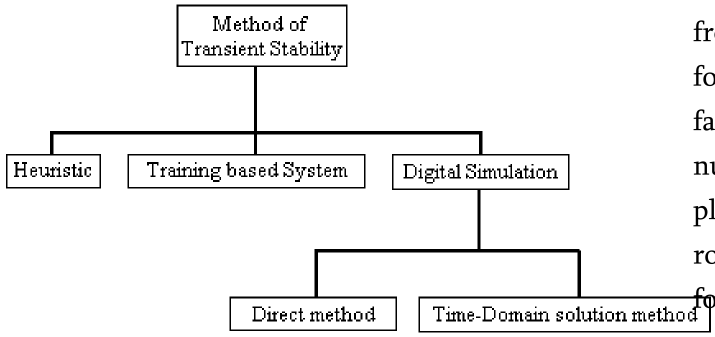
Transient stability is part of rotor angle stability. If the magnitude of disturbance is very large dynamics of rotating machine affected more hence dynamic equation of rotating machine including that automatic voltage regulator, exciter, prime mover and generator will appear in mathematical calculation of stability analysis. Example of large disturbance like sudden change in load, loss of generator unit, change in transmission line parameter, switching and various faults etc.

II. METHODS OF ANALYSIS

A variety of transient stability assessment methods have been classified into main three groups

A) Heuristic
B) Training based System

C) Digital Simulation



A. Heuristic Method: Heuristic or expert methods use the concept of artificial intelligence. In this approach, engineering knowledge is encoded into the sets of rules in a program. The program itself then forms two cores: the database and decision rules. a large number offline studies are required for a range of power system operating points and disturbances to form the required database.

B. Training Based System: Artificial neural networks and pattern recognition have been also used for transient stability analysis and classify as training system models. In these methods, the training sets are formed base on offline studies to form the pattern vector. Then the classifier needed to be designed for subsequent use in making decision online. Artificial neural networks have advantages over the traditional classifier as, after training ANN's have capability of generalizing.

C. Digital Simulation Method: Artificial neural networks and pattern recognition have been also used for transient stability analysis and classify as training system models. In these methods, the training sets are formed base on offline studies to form the pattern vector. Then the classifier needed to be designed for subsequent use in making decision online. Artificial neural networks have advantages over the traditional classifier as, after training ANN's have capability of generalizing.

1) Time Domain Solution Method:

In this method the initial system state is obtained from the pre-fault system. This is starting point used for integration of fault on dynamic equation. After the fault is cleared, the post fault dynamic equations are numerically integrated. The machine angle may be plotted versus time and analyzed. A maximum relative rotor angles threshold is nominated in practical for forming the transient stability criteria. For power system to be transiently stable, the maximum relative rotor angles of all generators are to be less than the transient stability threshold. If this angles are bounded, the system is stable otherwise unstable.

2) Direct Method:

As time domain simulation methods were computationally expensive, some efforts were taken to assess the power systems transient stability directly, and without solving DAEs of power system. The first direct method which was used in power system transient stability was the equal area criteria (EAC) for single machine infinite bus(SMIB).the method is able to find the critical clearing time without the solving the system DAEs.

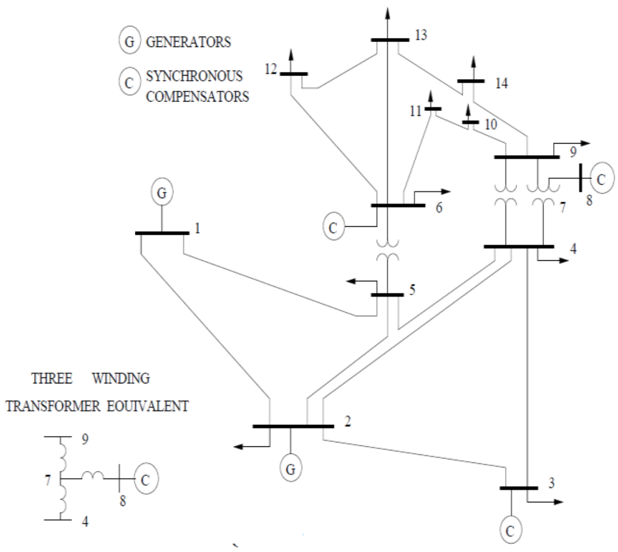
Lynapunav's method was adopted in the power systems multi machine transient stability for first time[6] .the application of Lynapunav's method to power system is called **transient energy function**(TEF).these methods compare the energy of the system when the fault is cleared to the critical energy value of the system. if the system energy at fault clearing time, is less the critical energy value, the system will be stable following disturbance however there are number of disadvantages in this methods. In practice it's require to simplify power system model deriving the energy function. It is difficult, if not impossible to include the detailed dynamic model of generators load and FACTS devices in derivation of the transient energy function. Furthermore, it is not straight forward to determine threshold value of the energy function for defining stability margin.

III. IEEE 14 BUS CASE STUDY

In the Machine 14 Bus systems is taken as case study which is shown in Figure. Bus-1 and bus-2 are generator buses which are rated 69kv with 100MVA base, Synchronous Compensators are connected at buses 3 and 8. Load is connected to all bus except bus-1,7and 8. Parameters given here are in per unit (p.u) format on 100MVA base. There are four transformers connected in the system; in which one is three-winding and others are two winding transformers.

IV. SIMULATION

A. Load flow Analysis



First in transient stability analysis a load flow study is performed to obtain a set of feasible steady state system conditions to be used as initial conditions. In ETAP software simulation system bus voltage magnitude and angle (unknown variable) by solving the nonlinear algebraic network equation using fast decoupled method so that specified load are supplied. As solution progresses, if voltage at load bus find out of limits then corresponding adjustment are made to bring their voltage back in range. At end of solution process either solution has converged or the number of allowed iteration has exceeded a solved load flow case is require to set the operating condition used to initialized for transient stability analysis. Fig.1shows Load flow plot in ETAP software which will indicate Active power, Reactive power flow in transmission line and Bus voltages.

	MW	Mvar	MVA	% PF
Source(swing buses)	232.414	-16.123	232.973	99.76 leading
Source(non-swing buses)	40.000	102.575	110.098	36.33 lagging
Total demand	272.414	86.452	285.803	95.32 lagging
Total motor load	259.000	77.400	270.318	95.81 lagging
Total static load	0.002	-21.157	21.157	0.01 leading
Apparent losses	13.412	30.209		
System mismatch	0.000	0.000		

B. Transient Stability Analysis

Transient stability of a power system is its ability to maintain synchronous operation of the machines when subjected to a large disturbance. The occurrence of such a disturbance may result in large excursions of the system machine rotor angles and, whenever corrective actions fail, loss of synchronism results among machines. Generally, the loss of synchronism develops in very few seconds after the disturbance inception. Transient stability is the fastest to develop.

Transient Stability Result:

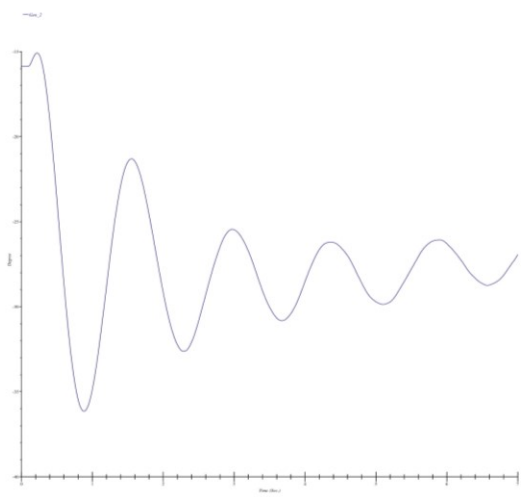


Fig.2 Plots of swing curve of gen.-2 during fault at bus-9

The fault occurs on Bus 9 very close to bus 7 and far Away from the generating stations.

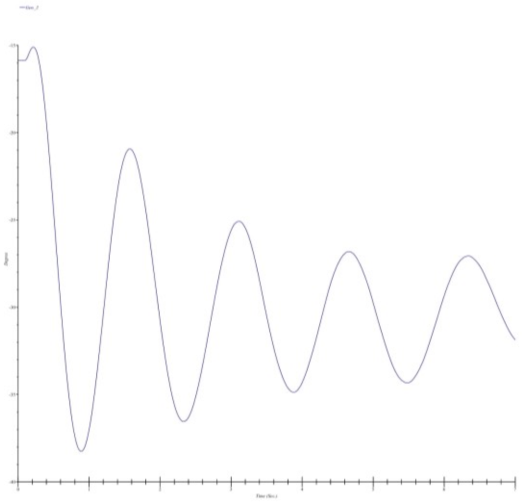


Fig.3 Plots of swing curve of gen.-2 during fault at bus-7

The fault occurs on Bus7 very close to bus 9 and far
Away from the generating stations

Discussion of the effect of fault location

There are many factors affecting the critical clearing time. Here, the effect distance between the fault location and the Generating stations is studied. Two fault locations for the same values of the damping and inertia constants are considered. One of the faults is on bus-7 very close to bus 9 which is connected to generator-2

IV.CONCLUSION

In this transient stability analysis of 14 bus we can come to know fault location effect on generator with given specific fault clearing time. we can say that as fault location is far away from generator then machine is more stable and if fault is occur nearer to generator the machine is under severe oscillation and may get out of stable so its rotor inertia mass will help damp out -oscillation.

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