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A REVIEW ON POWER SYSTEM STABILITY ANALYZER

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ABSTRACT

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A power system stability analyser (PSSA) installed in the excitation system of the synchronous generator improves the small-signal power system stability by damping out low frequency oscillations in the power system. It does that by providing supplementary perturbation signals in a feedback path to the alternator excitation system. In our project we review different conventional PSSA design techniques along with modern adaptive neuro-fuzzy design techniques.

Power system stability analyser is related to principles of rotational motion and the swing equation governing the electromechanical dynamic behavior.In this thesis we'll review different conventional PSSA design techniques along with modern adaptive neuro-fuzzy design techniques.

Keywords: Power System Stability, Electrical Power Management, Power Optimization

INTRODUCTION

Power system stability may broadly be defined as that property of a power system that enables it to remain in a stable equilibrium state under normal operating conditions and to regain an acceptable equilibrium state after being subjected to a disturbance [1]

Power System Stability, its classification, and problems associated with it have been addressed by many IEEE publications. The IEEE power systems dynamic performance committee defines power system stability as:

"Power system stability is the ability of an electrical power system, for given operating conditions, to regain its state of operating equilibrium after being subjected to a physical disturbance, with the system variables bounded, so that the entire system remains intact and the service remains uninterrupted".

There are three fundamental assumptions in all stability studies:-

a) Any synchronous frequency currents and voltage are considered in the stator windings and the power system
b) Symmetrical components are used in the representation of unbalanced faults.
c) Generated voltage is considered unaffected by machine speed variations.

For the purpose of analysis, there are three stability conditions as shown in Fig. 1. They are explained in the following sections.

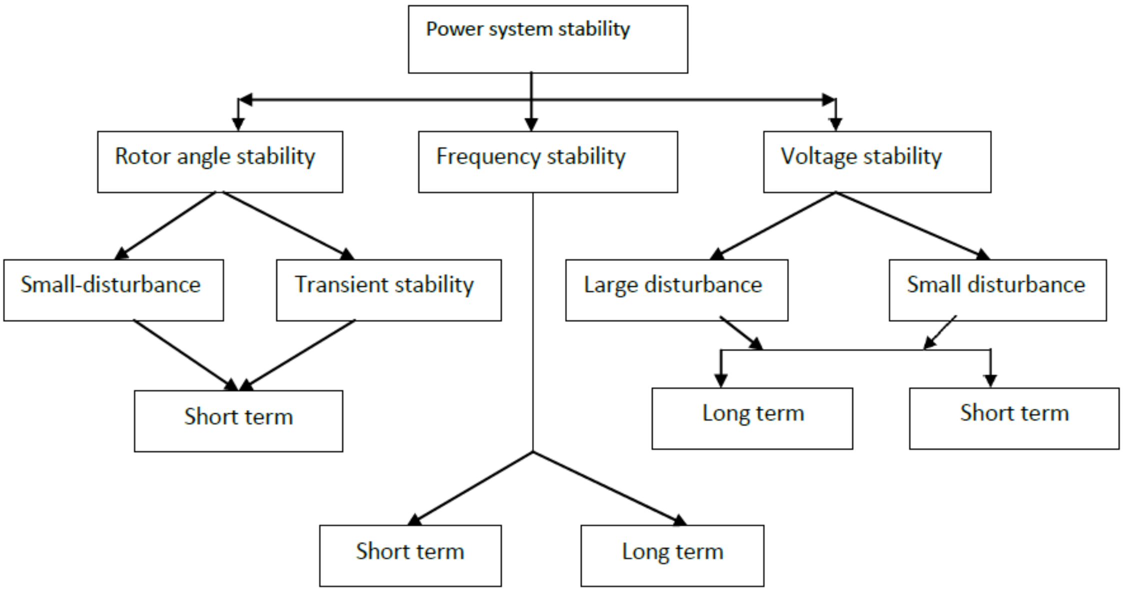

Fig.1. Power-system stability classification.

Power system is a dynamic and nonlinear system. State of the system is the instant information that is necessary for the system to get the next performance. It combines the different inputs of the information of a system. The states change from time to time. It can be chosen from any physical variables. State-space is a method to understand power system from n dimensions. Power system can be expressed by m th order nonlinear differential equations given by:

$$\dot{x}_i = f_i(x_1, x_2, \ldots, x_m; u_1, u_2, \ldots, u_q; t)$$

Where x refers to the states of the system at different time, u is the input of the system, t is noted as time, • x is the state differential variables along with the time [2, 3].

Factors Affected on Power System Stability

Stability of a nonlinear system depends on the type and magnitude of inputs, and the initial state [4]. Power system stability is affected by many factors including the behavior and characteristics of system equipment, system control and protection schemes. The most important factors can be summarized by:

- Pre-and-post-disturbance system state such as the generators loading before the fault and the generator outputs during the fault. The higher the loading before the fault is the more likely to be less stable during faults.
- The duration, location and type of the fault determine the amount of kinetic energy will be gained. Longer fault duration allows generator rotors to gain more kinetic energy during the fault. At certain limit, the gained energy may not be dissipated after the fault clearance. This gained energy may lead to instability.

Power System Modelling and Stability Analysis

The power system comprises a large number of electrical components. The modern systems have become more complex as they are enhanced with new devices such as Flexible AC Transmission System devices (FACTs) and Distributed Generation technologies [5]. The analysis of power system dynamics have been characterized by complex dynamic behaviour due to the modelling complexity and interactions/interrelations among individual components as well as the computational structure for describing modern power systems. Modeling of power system dynamics have been associated with describing each individual component by algebraic and/or differential set of equations. Combining the individual dynamic models together with the associated algebraic constraints and power flow equations leads to the dynamic model of the whole power system.

A modern excitation system contains components like automatic voltage regulators (AVR), Power System stability analyzer (PSSA), and filters, which help in stabilizing the system and maintaining almost constant terminal voltage. These components can be analog or digital depending on the complexity and operating conditions [6].

Stability Issues And The PSSA

Traditionally the excitation system regulates the generated voltage and there by helps control the system voltage. The automatic voltage regulators (AVR) are found extremely suitable (in comparison to "ammortisseur winding" and "governor controls") for the regulation of generated voltage through excitation control. But extensive use of AVR has detrimental effect on the dynamic stability or steady state stability of the power system as oscillations of low frequencies (typically in the range of 0.2 to 3 Hz) persist in the power system for a long period and sometimes affect the power transfer capabilities of the system. The power system stability analyzer (PSSA) were developed to aid in damping these oscillations by modulation of excitation system and by this supplement stability to the system. The basic operation of PSSA is to apply a signal to the excitation system that creates damping torque which is in phase with the rotor oscillations [7].

A typical power system stability study consists of the following steps:

1. Make modeling assumptions and formulate a mathematical model appropriate for the time-scales and phenomena under study;
2. Select an appropriate stability definition;
3. Analyze and/or simulate to determine stability, typically using a scenario of events;
4. Review results in light of assumptions, compare with the engineering experience ("reality"), and repeat if necessary.

Conclusion

In this review paper, Analysis of various types of power system stability such as steady state stability, transient stability have been done.

This report has addressed the issue of stability definition and classification in power systems from a fundamental viewpoint and has examined the practical ramifications of stability phenomena in significant detail. A precise definition of power system stability that is inclusive of all forms is provided. A salient feature of the report is a systematic classification of power system stability, and the identification of different categories of stability behavior. Linkages between power system reliability, security, and stability are also established and discussed. The report also includes a rigorous treatment of definitions and concepts of stability from mathematics and control theory. This material is provided as background information and to establish theoretical connections.

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