Comprehensive Study of Main Issues in Electrical Power Grid Stability Using the Modern Nonlinear Theory (Bifurcation and Chaos)

Ahmad Harb

Department of Energy Engineering,German Jordanian University, Amman, Jordan, aharb48@gmail.com

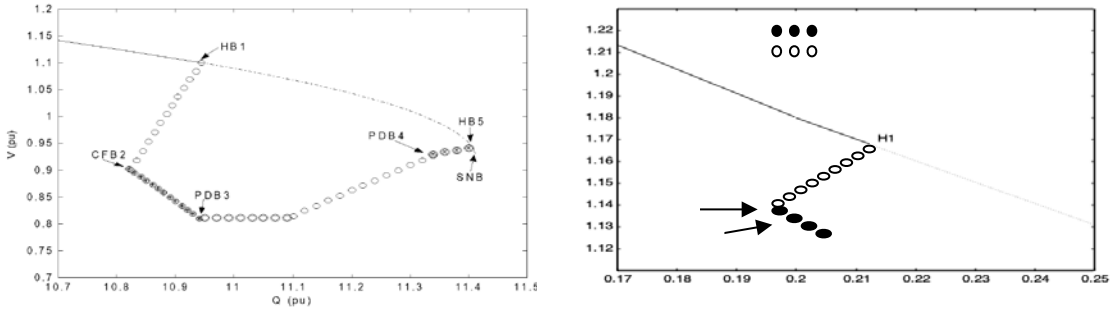
Abstract: In this paper, the bifurcation and chaos theory will be used to study the dynamics of two well known phenomena in electric power systems named Voltage Collapse (VC) and Subsynchronous Resonance (SSR). The results showed that at certain control parameter value, the system is experienced un stable condition, means the electric power system will totally collapse. After finding such un-stability conditions, we designed a nonlinear controller to mitigate all such un stabilities.

Introduction

It is well known that the electric power system is highly nonlinear system whose dynamics performance is influenced by a wide array of devices, with different response rates and characteristics. Under these stressful operating conditions, we are paying attention to two crucial instability problems called VC and SSR. These two main issues are happening frequently in electric power system all over the world. As power system become more complex and more heavily loaded, voltage collapse becomes an increasingly serious problem. Also, to reduce the transmission lines losses we add series capacitors and these capacitors had a bad impact to stability of the power system, with a phenomenon called SSR. Many investigators have linked these phenomena (VC and SSR) either to a static bifurcation [1], in particular, saddle-node bifurcation or to a dynamic bifurcation [2]. More recently, efforts have been directed at control of bifurcation and chaos in dynamical system. Thus, emphasis has been placed on design techniques which result in prescribed nonlinear dynamics for controlled processes. Bifurcation control deals with control input to modify the bifurcation characteristics of a parameterized system.

Results and Discussion

In this paper, by using bifurcation and chaos theory on the dynamics and control of electric power system for both phenomena (VC and SSR), results showed that under some disturbances such as huge load (loss or added to the system), or electrical fault on power system, un-stability will definitely occur, and make the system to be collapsed via either VC or SSR phenomena, as shown in Fig. 1. So, a nonlinear control, which will be presented in the length paper is been designed to regain stability to both systems.



(a) **(b)**

Figure1: Bifurcation diagrams (a) for Voltage Collapse and (b) for SSR Phenomena

References

[1] Schlueter R.A, (1988), Voltage stability and security assessment", EPRI Final Report El-5967 on Project RP 1999-8.

[2] Nayfeh A.H., Harb A.M., and Chin C. (1996), Bifurcation in a Power System Model, International Journal of Bifurcation and Chaos, Vol 6, No. 3.