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COMPUTATION OF STEADY-STATE SECURITY REGIONS, STABILITY REGIONS AND BIFURCATIONS OF POWER SYSTEMS

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Abstract. This paper is devoted to the problems of finding the steady-state security and stability region, saddle node, and Hopf bifurcation boundaries of power systems in the parameter space. A new method is proposed for the computation of these boundaries of power systems. Firstly, the steady-state security and stability region are sliced by a set of given parallel hyperplanes in a given direction, and then the boundary of each intersection region of the region is calculated by the approach of optimization. Furthermore, the visualization of the security region in the injection space is realized. This visualization feature is useful to the load dispatcher. Finally, practical examples are solved using the proposed method so as to demonstrate its effectiveness.
Keywords. Security region, stability region, bifurcation, power flow equations, security constraints, optimization.
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1 Introduction

In the study of a power system, a fundamental question is whether or not the system could sustain its operation under new conditions. This question is a steady-state stability problem [1], or steady-state security region problem [2,3]. The steady-state operation of a power system requires that the power supply and the load demand be balanced. It is described by a set of nonlinear equations known as the power flow or load flow equations. Next, it is clear that the system is required to be operated within the designed limits of the equipment used. These physical restrictions are described by a set of inequality constraints. They are sometimes referred to as the security constraints. As in [2], the steady-state security region is defined as a set of power injections on which the power flow equations and the security constraints are satisfied. A method for finding the dynamic security region is presented in [3]. In [4,5,6], the rectangular coordinates of the power flow equations are used to study the general structure of the load flow and to derive linear and quadratic approximation formulas for the characterizations