

論文の要旨

題目 ROBUST POWER SYSTEM SECURITY ASSESSMENT AGAINST UNCERTAINTIES

(不確定環境における電力システムのロバスト信頼度評価)

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In recent years, most countries are introducing renewable energy (RE) as an alternative energy resource instead of the conventional power plants. The foremost types of renewable energy resources widely employed in the world are photovoltaic (PV) and wind power. However, the quick development of large scale RE generation and its integration to power system grid lead to severe problems relating to the reliability of power system network. Especially, uncertainties and intermittency of RE outputs threaten the power system security. The increase in RE implies reduced controllable resources which make system security problem critical. Therefore, it is important to evaluate the robustness of the system controllability in order to preserve system security against uncertainties of RE outputs. In this thesis, the robustness of the system in this context is referred to as “Robust Power System Security.” Two types of security regions for static operating point and dynamic transition of system operation are defined, which are Robust Static Security (RSS) and Robust Dynamic Feasible (RDF) regions, respectively. The thesis is summarized as follows:

Chapter 1 presents the background of this research, the impact of uncertainties of RE, types of disturbances on power system security. Then, the proposed approaches are outlined.

Chapter 2 describes basic concept and definition of power system security, including a brief overview of conventional methods. The concept of Robust Power System Security dealing with uncertainties is described as an introduction to the following chapters.

Chapter 3 presents a new approach for RSS problem applied to static economic dispatch. The proposed method is to obtain upper and lower bounds of security region. The difference between the bounds indicates the diameter of security region, which can be used as a security measure. Linear programming (LP) is employed to solve the RSS problem. The effectiveness of the proposed method is demonstrated taking into account uncertainties of PV generations.

Chapter 4 provides the extension of RSS problem. In order to measure the security region in dynamic power system operation circumstances, RDF area is defined. A bi-level optimization problem is formulated to monitor RDF region. Then, the problem is linearized and transformed into mixed integer linear programming (MILP) problem, which can be effectively solved. The proposed approach is demonstrated using six-bus, IEEE 14-bus, IEEE 30-bus, and IEEE 118-bus standard models taking into account all dynamic factors in power system operation. It is shown that the method clearly indicates dangerous operating hours in a 24-hour system operation.

Chapter 5 presents the resume of the major achievements. Further, the future research works are discussed in relation to the thesis.