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Power System Reliability Monitoring and Control for Transient Stability

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Abstract;
Transient Stability (TS) is a critical factor limiting maximum power transfer in West Japan interconnected power system, where uncertainties are increasing due to rapid expansion of renewable energy (RE) such as photovoltaic (PV) generations. Although various research studies have been carried out concerned with power system operation problems related to RE, it is difficult to deal with TS problems with uncertainty. Analysis is required for possible future situations so that an effective countermeasure is developed in order to maintain system reliability.

We first analyze situations where PV generations may cause stressed conditions that TS becomes critical in IEEJ West Japan 30-generator system. As a possible countermeasure, we propose a real-time TS monitoring method in terms of critical clearing time (CCT) for contingencies. CCT may effectively be computed using Critical Trajectory Method. Then, in order to enhance TS, we investigate the use of the sensitivity of CCT with respect to node injection power, that is a kind of distribution factors which is useful for a preventive control.

In the final part, we present a reliability evaluation method for an operation planning with uncertainty. We show that the distribution factor for CCT is effective for a secure power system operation. A bi-level optimization [1] is used to deal with TS to obtain (1) the worst case optimal operation under uncertainty. The method also provides (2) the size of the feasible region, and (3) that for the worst case of uncertainty, where positive size implies feasibility while negative, infeasibility. We call this approach “Robust Security” that can detect the worst case of uncertainty.

Reference:

[1] N. Yorino, M. Abdillah, Y, Sasaki, Y. Zoka, “Robust Power System Security Assessment under Uncertainties Using Bi-Level Optimization”, IEEE Trans. Power Systems, to appear, 2017.