Power Systems Dynamic Security Enhancement by the use of Efficient Heuristics

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Abstract:

Power systems security is of paramount importance for the development of any country, once blackouts cause huge economic losses and social trouble. It is associated with the safety measures needed to prevent any equipment stress in the operation of an electrical network. Stressed equipments may be switched off by their protective relays and it may result in a cascade of events causing a partial or a major blackout. Generation active power dispatch and network voltage profile are the main control variables that can be adjusted to guarantee a safe steady state operation, under normal condition, or in the event of a set of credible contingencies. More recently a new concern has arisen, regarding the dynamic response of the system, once the post-contingency steady state may not show the poor damped oscillations that may cause a system collapse. They result from the electromechanical interaction between the massive rotating generators. Therefore, power systems dynamic security seeks for the safe operation of the electrical network, without any equipment stress and with the capacity of keeping synchronism among all generators, under normal and faulted conditions.

The dynamic security problem is usually solved by specialists, who investigate the worst scenarios using conventional simulation tools. It is quite likely that the solution provided by such conservative procedure is not the best solution from an economic perspective, for example. This work proposes an approach considering more realistic premises and based on intelligent optimization techniques.

There are already some initiatives in this area that can be classified basically in two different classes of algorithms. The first one corresponds to the use of optimal power flow, while the second one is based on the use of artificial intelligence or fuzzy logic. Dynamic modeling is the major drawback on both.

The motivation of this work is to make use of the generalization capacity, provided by metaheuristics, to use the response of complete time domain simulations as the fitness function. This means a more reliable approach, once there is no simplification, i.e. all system dynamics are considered. The fitness function corresponds to the stability margin, which is computed for each generator and for each contingency. This margin indicates how far from loosing synchronism the generator is. The fitness function corresponds to the smallest margin considering all generators and all contingencies. A bigger margin indicates a safer system.

Due to the innovativeness of the method, two different implementations will be tested. One based on an evolutive algorithm and the other based on a GRASP algorithm. These algorithms have been tested with the Anderson and Fouad test case, which has 9 buses and 3 generators and the IEEE 14 buses case, which has 6 generators.

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