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Using genetic algorithm and TOPSIS technique for multiobjective reactive power compensation

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ABSTRACT

A new approach to solve the multiobjective reactive power compensation (RPC) problem is presented. It is based on the combination of genetic algorithm (GA) and the ε-dominance concept. The algorithm maintains a finite-sized archive of nondominated solutions (Pareto solution) which gets iteratively updated in the presence of new solutions based on the concept of ε-dominance. The use of ε-dominance makes the algorithms practical by allowing a decision maker (DM) able to control the resolution of the Pareto set approximation according to his needs. The proposed approach is suitable to RPC problem where the objective functions may be ill-defined and having nonconvex Pareto-optimal front. It gives a reasonable freedom in choosing compensation devices from the available commercial devices. It may save computing time in cases of small archive.

Moreover to help the DM to extract the best compromise solution from a finite set of alternatives a TOPSIS (Technique for Order Performance by Similarity to Ideal Solution) method is adopted. It is based upon simultaneous minimization of distance from an ideal point (IP) and maximization of distance from a nadir point (NP).

The proposed approach is carried out on the standard IEEE 30-bus 6-generator test system. The results demonstrate the capabilities of the proposed approach to generate true and well-distributed Pareto-optimal nondominated solutions of the multiobjective RPC problem in one single run.

1. Introduction

Reactive power compensation (RPC) in power systems is a very important issue in the expansion planning and operation of power systems. Its main aim is to determine the adequate size and the physical distribution of the compensation devices to ensure a satisfactory voltage profile while minimizing the cost of compensation. Traditionally, this problem is considered as a single objective optimization problem (SOP) [5,7,15] where only one objective is optimized. Practically most problems have more than one objective to be optimized, e.g. RPC problem requires the optimization of: investment, power losses, and voltage profile. The objectives are usually contradictory. Accordingly a single objective optimization algorithm will not be preferable to solve the RPC problem. Considering this situation, multiobjective optimization algorithms (MOA) were proposed to optimize independent and simultaneously several objectives [1–4,9,20,22].

Traditional multiobjective optimization algorithm usually provides a unique optimal solution [13]. On the contrary, multiobjective optimization evolutionary algorithms (MOEA) independently and simultaneously optimizes several parameters turning most traditional constraints into new objective functions [1–4,14]. This seems more natural for real world problems where choosing a threshold may seem arbitrary [21]. As a result, a wide set of optimal solutions (Pareto set) may be found. Therefore, an engineer may have a whole set of optimal alternatives before deciding which solution is the best compromise of different (and sometimes contradictory) features.

Accordingly MOEA and specially those adopting GA have attracted the attention to solve the RPC problem. Some of these techniques suffer from the large size problem of the Pareto set [9]. Therefore some methods have been proposed to reduce the Pareto set to a manageable size. However, the goal is not only to prune a given set, but rather to generate a representative subset, which maintains the characteristics of the general set. Strength Pareto evolutionary algorithm (SPEA) [24] have been developed using cluster analysis (average linkage method) to reduce the size of the Pareto set. SPEA was adopted in [2–4], but unfortunately it does not take the DM preference into consideration.

In this paper the problem of RPC is solved based on GA. The algorithm is a MOEA with an external population of Pareto-optimal solutions that best conform a Pareto Front [21]. To avoid an

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