Finding optimal configuration of power distribution systems topology is an NP-hard combinatorial optimization problem. It becomes more complex when time varying nature of loads in large-scale distribution systems is taken into account. In the second chapter of this dissertation, a systematic approach is proposed to tackle the computational burden of the procedure. To solve the optimization problem, a novel adaptive fuzzy based parallel genetic algorithm (GA) is proposed that employs the concept of parallel computing in identifying the optimal configuration of the network. The integration of fuzzy logic into GA enhances the efficiency of the parallel GA by adaptively modifying the migration rates between different processors during the optimization process. A computationally efficient graph encoding method based on Dandelion coding strategy is developed which automatically generates radial topologies and prevents the construction of infeasible radial networks during the optimization process.

The main shortcoming of the proposed algorithm in Chapter 2 is that it identifies only one single solution. It means that the system operator will not have any option but relying on the found solution. That is why a novel hybrid optimization algorithm is proposed in the third chapter of this dissertation that determines optimal Pareto frontiers, as candidate solutions, for multi-objective distribution network reconfiguration problem. Implementing this model, the system operator will have more flexibility in choosing the best configuration among the alternative solutions. The proposed hybrid optimization algorithm combines the concept of fuzzy Pareto dominance (FPD) with shuffled frog leaping algorithm (SFLA) to recognize non-dominated suboptimal solutions identified by SFLA. The local search step of SFLA is also customized for power systems applications so that it automatically creates and analyzes only the feasible and radial configurations in its optimization procedure which significantly increases the convergence speed of the algorithm.

In the fourth chapter, the problem of optimal network reconfiguration is solved for the case in which the system operator is going to employ an optimization algorithm that is automatically modifying its parameters during the optimization process. Defining three fuzzy functions, the probability of crossover and mutation will be adaptively tuned as the algorithm proceeds and the premature convergence will be avoided while the convergence speed of identifying the optimal configuration will not decrease. This modified genetic algorithm is considered a step towards making the parallel GA, presented in the second chapter of this dissertation, more robust in avoiding from getting stuck in local optimums. In the fifth chapter, the concentration will be on finding a potential smart grid solution to more high-quality suboptimal configurations of distribution networks. This chapter is considered an improvement for the third chapter of this dissertation for two reasons: (1) A fuzzy logic is used in the partitioning step of SFLA to improve the proposed optimization algorithm and to yield more accurate classification of frogs. (2) The problem of system reconfiguration is solved considering the presence of distributed generation (DG) units in the network.

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The public is welcome to attend.