

Genetic Algorithm approach in FACTS devices location for the improvement of energy efficiency in distribution networks

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1 Interest of work

The European Union ratified the Kyoto Protocol in May 2002 and committed to reduce emissions of six greenhouse gases. There are different aspects to be considered in order to reach this goal and of them is energy efficiency in power systems. Energy efficiency can be improved along the power system and here the focus is set to the transmission and distribution network. Overall losses in a transmission and distribution system are considered normal in a range of 6% and 8%. There are different ways to achieve a better energy efficiency in distribution networks, such as high efficiency transformers and cables or applications like Flexible AC Transmission Systems (FACTS). More over, several optimization techniques can be applied to maximize energy efficiency in distribution networks. Several optimization techniques can be applied to maximize energy efficiency in distribution networks. Among them: Ant Colonies Optimization (ACO), [1]. Particle Swarm Optimization (PSO) [2]. Artificial Neural Networks (ANN), [3]. Evolutionary Programming (EP) [4]. Genetic Algorithms (GA) [5].

2 Objectives

The application of FACTS devices, employing a GA optimization technique, can actually improve energy efficiency in power systems. GA will be applied so that the location of FACTS devices and the reactive power considered are optimal. GA is applied to a power system of N_{bus} nodes to maximize energy efficiency (η). For each individual i out of the possible N , an array carries the values that represent the i -th individual: the node, N_{node} , the FACTS device reactive power Q_{facts} and the efficiency η_i . Two different MATLAB programs are applied to the distribution network:

- A power flow program to evaluate the network's efficiency;
- A GA based program to optimize FACTS location and so improve energy efficiency.

These programs are meant to evaluate the evolution of network efficiency through the number of generations along with the best node/best reactive power evolution. The process sorts out individuals of the population considering their efficiency values and evaluates the stop criterion set for the problem. Later on, the algorithm applies the GA rules that are necessary to grow the population and in the final phase the algorithm outputs the best values reached for each generation.

3 Main contribution

The algorithm is applied to a 33 bus radial distribution system using data presented in [6]. The simulation is set for a number of generation N_{gen} and the maximum number of best individuals is set to be N_{best} . These individuals are the new genitors of the new population and in order to establish the individuals ranking, system efficiency is evaluated through the power flow program. For each new population the first 3 individuals with the best efficiency are chosen to reproduce and their behavior is implemented considering their probability of reproducing, including also crossover and mutation. Figure 1 shows the evolution of the efficiency through the number of generations and also the evolution to the best node with the best reactive power input.

For this specific study the results obtained show an efficiency of $\eta_{GA} = 0.9405$. It is important to mention that as a consequence of using a random function to generate the value of α , the results may vary for each run of the program. This result show how the efficiency of the study network is actually improved.

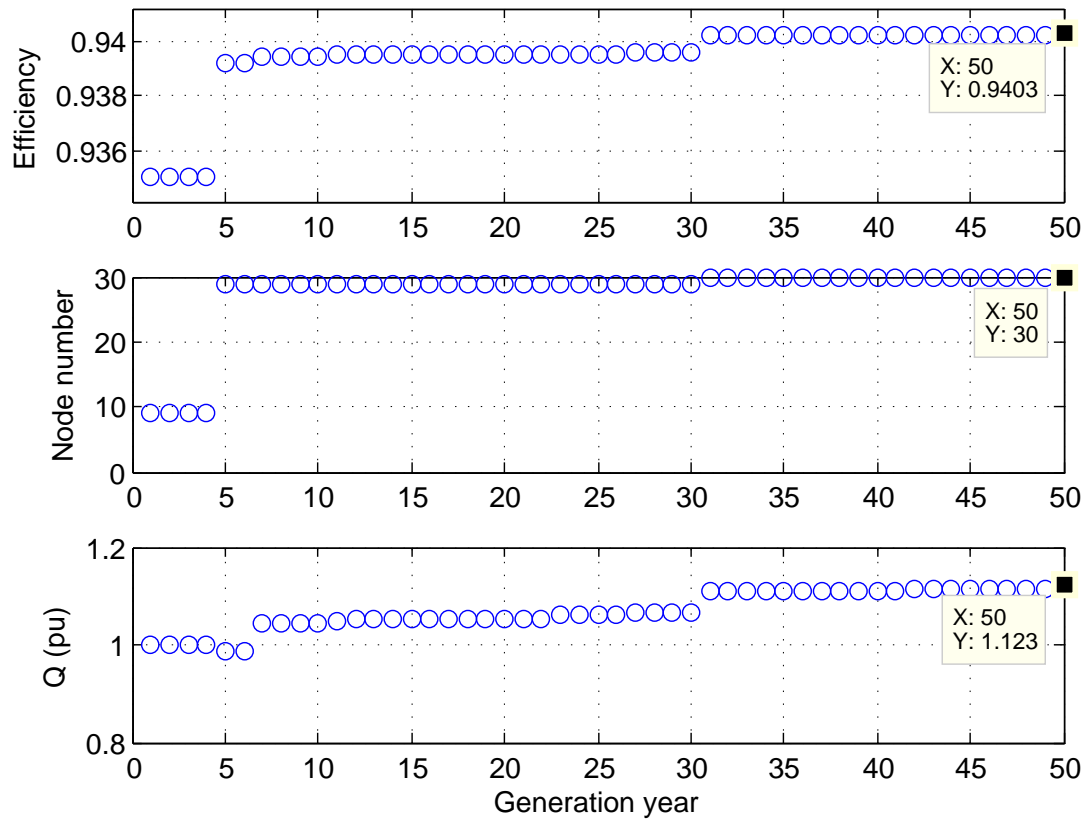


Figure 1: Efficiency Evolution

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