



Optimal reactive power dispatch based on harmony search algorithm

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ABSTRACT

This paper presents a harmony search algorithm for optimal reactive power dispatch (ORPD) problem. Optimal reactive power dispatch is a mixed integer, nonlinear optimization problem which includes both continuous and discrete control variables. The proposed algorithm is used to find the settings of control variables such as generator voltages, tap positions of tap changing transformers and the amount of reactive compensation devices to optimize a certain object. The objects are power transmission loss, voltage stability and voltage profile which are optimized separately. In the presented method, the inequality constraints are handled by penalty coefficients. The study is implemented on IEEE 30 and 57-bus systems and the results are compared with other evolutionary programs such as simple genetic algorithm (SGA) and particle swarm optimization (PSO) which have been used in the last decade and also other algorithms that have been developed in the recent years.

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1. Introduction

The Optimal Reactive power dispatch problem is affective on secure and economical operation of power systems. This problem denotes optimal settings of control variables such as generator voltages, tap ratios of transformers and reactive compensation devices to minimize a certain object While satisfying equality and inequality constraints. Transformer tap settings and reactive compensation devices are discrete values while bus voltage magnitudes and reactive power outputs of generators are continuous variables so the ORPD problem can be modeled using mixed integer nonlinear programming.

Up to now a number of mathematical programming approaches have been implemented to the ORPD problem. In [1–4] gradient based optimization algorithms have been used to solve the ORPD problem.

Recently interior-point methods have been implemented to the ORPD and the OPF problem. Interior-point linear programming [5] was used by Granville. Quadratic programming [6] was also implemented by momch. These methods are incapable in handling nonlinear, discontinuous functions and constraints, and problems having multiple local minimum points. In all these techniques simplifications have been done to overcome the limitations. In [7] Aoki handled discrete variables by an approximation–search method and Bakirtziss in [8] represented a linear-programming to handle the shunt reactive compensation devices.

Recently, stochastic search methods have been used widely for the global optimization problem. In [9] an Evolutionary Programming (EP) is applied by Wu for global optimization of a power system to accomplish optimal reactive power dispatch and voltage control. Lai in [10] showed EP is more capable of handling non-continuous and non-smooth functions comparing nonlinear programming. In [11] Lee used simple genetic algorithm (SGA) combined with successive linear programming to solve reactive power operational problem. Particle swarm optimization (PSO) was applied by Yoshida in [13] for reactive power and voltage control considering voltage security assessment. [14] Proposed a multi-agent based PSO by Zhao for the ORPD problem. In [15] Zhang used a fuzzy adaptive PSO for reactive power and voltage control. In [16] Differential evolutionary algorithm is implemented to the optimal reactive power dispatch problem. Kannan in [17] solved the ORPD problem by a CLPSO approach. Other approaches for solving this problem such as SARCGA and SOA are introduced in [18,19]. Finally a stochastic reactive power approach is solved by GA in [20].

In the few years harmony search algorithm (HSA) has been used for global optimization. HSA is a meta-heuristic algorithm which mimics the improvisation process of music players and has been developed in the recent years [21]. This algorithm has been used for optimization problems in a wide variety [22–26] which shows several advantages in comparison with conventional methods. These advantages are:

1. The mathematical operations used in this algorithm are very simple and also the control variables are selected randomly.

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