OPTIMAL REACTIVE/VOLTAGE CONTROL BY AN IMPROVED HARMONY SEARCH ALGORITHM

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ABSTRACT

This paper presents an improved harmony search algorithm for the optimal reactive/voltage control problem. Optimal reactive/voltage control 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 objective. The objectives 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 the IEEE 30 Bus system and the results are compared with other evolutionary programs such as harmony search algorithm (HSA) and particle swarm optimization (PSO).

Index Terms— Optimal reactive/voltage control; Harmony search algorithm; Optimization; Loss minimization

1. INTRODUCTION

Optimization of reactive/voltage control is necessary for the secure and economic operation of the power system. 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 this problem can be modeled using mixed integer nonlinear programming.

Up to now many mathematical approaches have been implemented to optimization problems. In [1-4] gradient based optimization algorithms have been used to solve the power system optimization problems. Recently interior-point methods have been used for solving the optimal reactive power dispatch and the optimal power flow problems. Interior-point linear programming [5] was used by Granville. Quadratic programming [6] was also used by momeh. These methods are incapable in handling nonlinear, discontinuous functions and constraints, and are usually stocked in local minima's. 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.

In the last decade stochastic optimization methods have been used for solving optimization problems. 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 multiagent based PSO by Zhao for the optimal reactive power dispatch problem. In [15] Zhang used a fuzzy adaptive PSO for reactive power and voltage control.

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 [16]. This algorithm has been used for optimization problems in a wide variety [17-21] which shows several advantages in comparison with conventional methods. These advantages are:

1. In this method there is no need for initial settings of control variables. Also few mathematical operations are required.
2. In this method no derivation operations is required as the searching process in stochastic.
3. In this algorithm the new control variables are generated after considering all the existing solution vectors. Despite this method in GA only two solution vectors are considered or in PSO only the best solution vector and the best previous vector of each particle is considered for generating the new solution vector.