Chapter 11

Hybrid Cuckoo Search Algorithm for Optimal Placement and Sizing of Static VAR Compensator

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ABSTRACT

This chapter proposes a Hybrid Cuckoo search algorithm to determine optimal location and sizing of Static VAR Compensator (SVC). Hybrid Cuckoo search algorithm is a simple combination of the Cuckoo search algorithm (CSA) and Teaching-learning-based optimization (TLBO), where the learner phase of TLBO is added to improve performance of Cuckoo eggs. The proposed method is applied for optimizing location and sizing of SVC in electric power system. This problem is a kind of discrete and combinatorial problem. The objective function considers loss power, voltage deviation and operational cost of SVC and other operating constraints in power system. Numerical results from three various tested systems show that the proposed method is better than the conventional CSA and TLBO in finding the global optimum solutions and its performance is also high than others.

INTRODUCTION

This chapter presents a hybrid version of the Cuckoo search algorithm (HCSA) and its application for determining optimal placement and sizing of Static VAR compensator (SVC) devices in the electric power system. The Cuckoo search algorithm is a nature-inspired optimization technique, which works on

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the parasitic behavior of Cuckoo species. The conventional method includes two probability-generating stages. In the first stage, The Lévy flight generates random Cuckoo eggs, and then these eggs will be laid into the neighbors' nests to create new solutions. The better solutions will carry over the next generation. The second stage describes the action of the host birds to abandon Cuckoo eggs in their nests. In this proposed Hybrid Cuckoo search algorithm, we combine the learner stage of the Teaching-learning-based optimization to improve performances of Cuckoo eggs instead of abandoning them. The proposed method is applied for optimizing location and sizing of SVC devices to enhance the voltage profile of the power system. This problem combines discrete and continuous unknowns with many equal and unequal constraints. The discrete unknowns are natural numbers representing the location of installed SVC devices, and the continuous unknowns represent injected reactive power of SVC devices. The proposed method is evaluated on three IEEE standard systems and compared with both of conventional Cuckoo search algorithm and Teaching-learning-based optimization. Numerical results show that the proposed Hybrid Cuckoo search algorithm gives better solutions and has higher performance than other methods.

This chapter divides into seven sections. Section 2 gives the literature review of the Cuckoo search algorithm and the problem of optimal placement and sizing of SVC devices. Section 3 proposes the Hybrid Cuckoo search algorithm. Section 4 describes the structure of a SVC device and the objective function. In Section 5, the implement of Hybrid Cuckoo search algorithm for the problem has been discussed. Section 6 shows numerical results on three benchmark problems. Finally, conclusions are made.

BACKGROUND

Following the development of population-based optimization methods in recent years such as Particle swarm optimization (Kennedy & Ebemart, 1995) or Firefly algorithm (Yang, 2010a, 2010b), Yang and Deb proposed a powerful optimization technique with few controlling parameters; its name is Cuckoo search algorithm (Yang & Deb, 2009). At the first works to develop this method, Yang and Deb show that the Cuckoo search algorithm is better than particle swarm optimization and genetic algorithm in finding optimal solutions for 10 tested functions. After that, they applied the Cuckoo search algorithm for the Spring design optimization and the Welded beam design to proof that their method is favorable for engineering design problems (Yang & Deb, 2010). Then, many improvements and applications of the Cuckoo search were published. On a short survey of E. F. Shair et al, the number of journal papers concerning with the Cuckoo search algorithm increase rapidly from 2010 to 2013 (Shair et al., 2011). For example, E. Valian et al proposed an improved Cuckoo search algorithm and applied it for training neural network (Valian et al., 2011). In the improved Cuckoo search algorithm, they gave a strategy to change the step length α and probability rate p_a. At the beginning of search, p_a is a small value while α is a large one. These controlling parameters were adjusted by the change of iteration. The value of p_a is larger and the value of α is smaller by each generation. With the idea that makes the step size change following the iteration number, S. Walton et al. proposed a Modified CSA, where the step size α is depend of root square of iteration number (Walton et al., 2011). Furthermore, they used the golden ratio to create a new Cuckoo egg, which lay between the two top eggs. Their proposed method is better than the conventional CSA in some evaluated functions. Besides, few researchers tried to use different methods to generate the Cuckoo eggs instead of the Lévy flight. For instance, H. Zheng and Y. Zhou replace the Lévy flight by Gauss distribution (Zheng & Zhou, 2012). Results show that the Gauss distribution Cuckoo search algorithm is better than conventional one in seven benchmarks. Furthermore, modern

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