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Firefly Algorithm based on Fuzzy Mechanism for Optimal Congestion Management

Aref Jalili[1], Mansour Hosseini Firouz[1], Noradin Ghadimi[2]*

1Department of Engineering, Ardabil Branch, Islamic Azad University, Ardabil, Iran
2Young Researchers and Elite club, Ardabil Branch, Islamic Azad University, Ardabil, Iran
**Author for Correspondence*

ABSTRACT

This paper presents optimal congestion management in an electricity market using Firefly Algorithm (FA) and Fuzzy mechanism. The FA is a meta-heuristic, nature-inspired, optimization algorithm which is based on the social (flashing) behavior of fireflies, or lighting bugs, in the summer sky in the tropical temperature regions. Transmission pricing and congestion management are the key elements of a competitive electricity market based on direct access. They also focus of much of the debate concerning alternative approaches to the market design and the implementation of a common carrier electricity system. This paper focuses on the tradeoffs between simplicity and economic efficiency in meeting the objectives of a transmission pricing and congestion management scheme. The effectiveness of the proposed technique is applied on 30 and 118 bus IEEE standard power system in comparison with CPSO, PSO-TVAC and PSO-TVIW. The numerical results demonstrate that the proposed technique is better and superior than other compared methods.

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Introduction

The emerging energy markets take on various forms. Depending on particular regional characteristics some markets admit centralized day-ahead and hour-ahead markets for wholesale trading and a real-time energy market for balancing while others only offer one or two centralized markets, and still other offers only bilateral contracts among market participants with no centralized markets. The model of Multilateral Transaction is based on bilateral transactions between market participants without the presence of centralized market. The system operator, upon receiving the proposed transactions, makes decisions to have allowed or not to the transactions based on analysis of transmission network constraints. Only when the proposed transactions violate transmission limits, the operator interferes of system and suggests necessary modifications needed to the transactions through "loading vector" [1-2].

Optimal Power Flow (OPF) has probably been the most significant technique for obtaining minimum cost generation patterns in a power system with existing transmission and operational constraints [3]. The problem of dispatch has been formulated with two different objective functions: cost minimization and minimization of transaction deviations. The congestion charges can be calculated in both the cases. These can then be incorporated in the problem of OPF to efficiency the incremental/decremental change in the generator outputs. Similarly, in the bilateral market mode case, every transaction contract can include a compensation price that the buyer-seller pair is willing to accept should its transaction be curtailed [4].

Actually, several OPF based congestion management schemes for multiple transactions have been proposed recently. The minimum total modification to the favorable transactions for relieving congestion is presented in [5]. In [6] a number of Congestion management approaches are presented. Congestion factor of distribution network is described in [7]. Ranking zone categorized by sensitivity index is divided to active and reactive power. This technique in computational aspect is complex. A variant of this least modification approach [8] used a weighting scheme with the weights being the surcharges paid by the transactions for transmission usage in the congestion-relieved network. In [9], an OPF which minimizes cost of congestion and service costs is proposed. A new working of congestion management in multilateral transaction networks has been developed based on physical flows [10].

In this paper, hybrid FA with fuzzy mechanism is proposed for re-dispatching system with congestion management to minimize cost, congestion lines for overload condition and satisfied production constraints and generator loads. The FA is a meta-heuristic, nature-inspired, optimization algorithm