Article

An Amended Whale Optimization Algorithm for Optimal Bidding in Day Ahead Electricity Market

Kavita Jain [1], Akash Saxena [1], Ahmad M. Alshamrani [2], Adel Fahad Alrasheedi [2], Khalid Abdulaziz Alnowibet [2] and Ali Wagdy Mohamed [3,*]

1 Department of Electrical Engineering, Swami Keshvanand Institute of Technology, Management and Gramothan, Jaipur 302017, Rajasthan, India
2 Statistics and Operations Research Department, College of Science, King Saud University, P.O. Box 2455, Riyadh 11451, Saudi Arabia
3 Operations Research Department, Faculty of Graduate Studies for Statistical Research, Cairo University, Giza 12613, Egypt
* Correspondence: aliwagdy@staff.cu.edu.eg

Abstract: Successful privatization in other sectors leads to a restructuring in the power sector. The same practice has been adopted in the electrical industry with a deregulated electricity market (EM). This enables competition among generating companies (Genco's) for maximizing their profit and it plays a central role. With this aim, each Genco gives a higher bid that may result in a risk of losing the opportunity to get selected at auction. The big challenge in front of a Genco is to acquire an optimal bid and this process is known as the Optimal Bidding Strategy (OBS) of a Genco. In this manuscript, a new variant of whale optimization (WOA) termed the Amended Whale Optimization Algorithm (AWOA) is proposed, to attain the OBS of thermal Genco in an EM. Once the effectiveness of new AWOA is proved on 23 benchmark functions, it is applied to five Genco strategic bidding problems in a spot market with uniform price. The results obtained from the proposed AWOA are compared with other competitive algorithms. The results reflect that AWOA outperforms in terms of the profit and convergence rate. Simulations also indicate that the proposed AWOA can successfully be used for an OBS in the EM.

Keywords: bidding strategies; electricity market (EM); market clearing price (MCP); whale optimization algorithm (WOA); Cauchy mutation (CM)

MSC: 68T01; 68T30; 65K10; 62J10

1. Introduction

After achieving successful results of privatization in several sectors, i.e., telecommunication, toll plaza, airlines, and many more, the reformation of the power industry was also started. The reformation of the power industry is termed the restructuring or deregulation of the electricity market (EM). The reason for deregulation in the EM is to restrict the monopolies of government or government authorities and provide a competitive platform for suppliers and buyers [1]. A competitive platform in the EM forces the generators to evaluate the cost in such a manner that they are in a risk-free zone. To reduce the risk of loosening the game with uncertainties of monopolistic market structure leads the EM to innovate a new structure of market termed oligopolistic market structure [2].

Due to certain limitations, i.e., large investment size, transmission constraints, transmission losses, etc., there are a limited number of buyers and sellers in an oligopolistic market. The aim of both buyer and seller in an oligopolistic market is to maximize their profit. All applicants submit their bids (for quantity (MW) and price ($/MW)) in a sealed envelope to the system operator (SO). The SO will finalize the market clearing price (MCP) after receiving the bids from all applicants (supplier and consumer). MCP is the effective