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2019 Women Institute of Technology Conference on Electrical and Computer Engineering (WITCON ECE)

Profit Maximization Bidding Strategy for a GENCO using Whale Optimization Algorithm

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***Abstract*—In a deregulated environment of electricity market,all participants of this market have intentions to increase their profit as much as possible in absentia of their competitor's bid prices.These optimal Bidding strategies are first obtained through some conventional methods but In a recent trend of meta-heuristic approaches,this stochastic optimization problem solved through different meta-heuristic approaches.Due to the popularity of stochastic optimization techniques.deterministic approaches are obsolete due to their inefficiency of solving this bidding problem.In the same line of order,This paper presents the application of recent meta heuristic approach namely,Whale Optimization Algorithm (WOA) to solve strategic bidding problem of a test system having 6 competitors and MCP and profit is obtained after optimization routine.The results confirms the supremacy of WOA over other meta-heuristic approaches.**

***Index Terms*—Strategic Bidding,Market Clearing Price,Uniform Market Clearing,Pay-As-Bid**

Nomenclature

MUT_k	Power producer's minimum up-time of k^{th} block
MDT_k	Power producer's minimum down-time of k^{th} block
$\alpha_k^{on}(t)$	Power producer's 'ON' time for k^{th} block at the completion of hour (h)
$\alpha_k^{off}(t)$	Power producer's 'OFF' time for k^{th} block at the completion of hour (h)
M	Total no. of rival companies
T_{off}	Total no of 'OFF' hours of unit at the time of starting
C_h	Hot-Start up costing
C_c	Cold-Start up costing
T_c	Constant to evaluate cooling time
$C_k(t)$	Power producer-P's operating cost for k^{th} block
C_k^u	Startup cost function in terms of nonlinear exponential function
C_k^d	Constant shut down cost
q_{k_m}	M^{th} Rival's k^{th} block bid price
$C_k^{'}(t)$	Production cost in terms of Non differentiable, non-convex function
$\overline{P_k}$	Power producer's upper limit of output of m^{th} block
$\underline{P_k}$	Power producer's lower limit of output of m^{th} block
$\chi_k(t)$	Binary Flag which is equal to 1 when unit is dispatching power or else it is zero.
r,s & u	Coefficients for cost evaluation
v,w	Constants for inclusion of Valve Point loading effect

I. Introduction

For most of the twentieth century,when consumers wanted to buy electricity then they had no choice.They had to buy it from the utility that held the monopoly for the supply of electricity in the particular area where these consumers were located.Restructuring of the power industry aims at abolishing the monopoly in the generation and trading sectors, thereby introducing competition at various levels wherever it is possible. In a perfectly competitive electricity market,generating companies should bid at or very close to their marginal cost to increase their profits.As we all know,higher bid price gives higher profits so the selection of bid prices in an uncertain pattern of rival's bid prices, major concern area for generating companies participating in electricity market.This problem of choosing appropriate bid price is known as " Strategic Bidding Problem".To solve this bidding problem different methods are presented in literature, a comprehensive review of these methods are given in [1]. Due to stochastic nature of bidding problem different stochastic optimization approaches are presented in literature which are solved by means of stochastic optimization methods in [2], [3], [4], [5], [6], [7] etc.

In these optimization solution methodologies, market complications are modeled by the distribution of the competitor offers and problem is resolved for power producer's profit maximization. However, to frame the strategy for a power producer, the competitor s' offer price statistics shows an essential role.The market structure reflected in this work is a pool market structure. All bids submitted by power producers comprises the bid price and quantity of power dispatch. These submitted bids are arranged in ascending order and the meeting junction between power demand and supply is obtained. This meeting point is acknowledged as market clearing price (MCP). The bids smaller than this price are accepted bid prices. To simulate this problem, we consider a uniform market price rule where the profits earned by the concern enterprises calculates with the help of MCP.In the same line of order ,a recently proposed algorithm by S.Mirjalili [8] namely Whale Optimization Algorithm(WOA) is used to solve this Strategic Bidding problem in this work. The rest of the paper is structured as follows: The problem formulation for bidding problem is described in section 2.The parent WOA [8] is explained in section 3. Section 4 gathers the details of all simulation results of bidding problem and section 6 concludes this paper.

II. Problem Formulation

Let us assumed that the competitors block price offers are already known from the literature. Bid prices of competitor's are evaluated by a normal probability distribution function which is written as,eq.no.(1),

$$pdf(\beta_k{}^m) = \frac{1}{\sqrt{2\pi}\sigma_k{}^m} \exp\left(-\frac{(\beta_k{}^m - \mu_k{}^m)^2}{2(\sigma_k{}^m)^2}\right) \quad (1)$$

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