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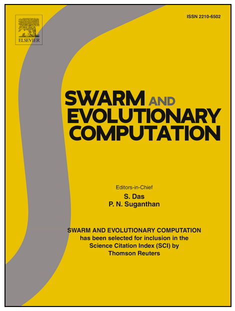

Optimal maintenance scheduling of generator units using discrete integer cuckoo search optimization algorithm

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Optimal Maintenance Scheduling of Generator Units using Discrete Integer Cuckoo Search Optimization Algorithm

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***Abstract*— In this paper, Discrete Integer Cuckoo Search (DICS) Optimization Algorithm is presented for generating an Optimal Maintenance Schedule for power utility with multiple generator units and complex constraints of Man Power Availability, Load Demand and strict Maintenance Window. The objective is to maximize and distribute the reserved power evenly across the fifty two weeks while satisfying the multiple constraints. This is a complex combinatorial NP-hard problem and there is no unique solution available for it. Nature inspired Cuckoo Search algorithm has been chosen to address this problem. Cuckoo search algorithm is a metaheuristic algorithm based on the obligate brood parasitism of cuckoo bird species, where cuckoo tries to find the best nest of other birds whose eggs resemble her own to lay her eggs to be hatched by other birds. Therefore the problem is formulated to find the best host nest. The host nest is defined according to the constraints of the power utility.**

The results obtained are compared with the work of previous researchers using the same test system and using the Genetic Algorithm with Binary Representation (GABR), Genetic Algorithm with Integer Representation (GAIR), Discrete Particle Swarm Optimization (DPSO), Modified Discrete Particle Swarm Optimization (MDPSO) and Hybrid Scatter Genetic Algorithm (HSGA). The results show that the DICS outperformed all the other algorithms.

***Index Terms*—Cuckoo Search; Swarm Intelligence; Generator Maintenance Scheduling; Combinatorial Optimization Problem.**

I. Introduction

The Implementation of Discrete Integer Cuckoo search algorithm has been carried on the Generator Maintenance Schedule Problem(GMS). The problem has 21 generator units, which need to be down for maintenance every year. Some generator units should be maintained in the first 26 weeks of the year and other generator units should be serviced in the latter half of the year. Table II gives the details of the maintenance requirements. Each generator unit has a different maintenance time, which can range form one week to ten weeks. Once the maintenace starts it should be finished in a single stretch

without any interruptions, i.e. if it needs to be down for 6 weeks, it should be down for 6 weeks and can not be split into two three months schedule.

Moreover there are constraints of manpower availability and the load demand each week, which should always be met. The goal is to find a maintenance schedule for generators where the surplus reserve power should be levelled across all the weeks. The leveling of the Reserve Power across maintenance schedules enhances the reliable operation of the utility to meet the unexpected fluctuations in load demand [1] and it is achieved by minimizing the Sum of Square of Reserve Power (SSR) in each maintenance time interval.

Fig. 1 shows how a total reserve power of 80 MW when distributed in two weeks as 60 MW and 20 MW or 40 MW and 40 MW each week, or when it is distributed equally in four weeks as 20 MW per week, SSR is the lowest when it is leveled among the four weeks.

Since, there are total of 21 generators and each generator can start its maintenance in one of the 26 weeks, The total search space = $(26)^{21} \sim 5.18 * 10^{29}$ solutions. Number of solutions grows exponentially with increasing number of generators. Therefore, Generator Maintenance Scheduling is a ***complex combinatorial optimization problem*** and there is ***no unique solution*** for it. It is NP hard (Non Deterministic Polynomial Time) problem, which cannot be solved in polynomial time. Therefore there is need to look at alternative algorithms inspired by nature.

Early approaches to solve the GMS problem include branch and bound technique, integer programming and dynamic programming [4-7]. K. P. Dahal and J. R. McDonald have discussed the severe drawbacks of these approaches such as inability to handle increased dimensionality and poor performance when the objective function is non-linear [3].

With the advent of Artificial Intelligence, various meta-heuristics algorithms were proposed for solving the GMS problem [1-3, 8-11]. Simulated annealing optimization method with mixed integer representation was proposed by Satoh, T., and K. Nara for the thermal GMS problem [8]. However this method suffered the drawback of long computational time of about 21 hours for large systems [3]. Huang, C. J., C. E. Lin, and C. L. Huang put forward a Fuzzy Approach for the GMS

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