Economic Operation of Unit Commitment Using Multiverse Optimization Algorithm

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Abstract: Security Constraint Unit commitment (SCUC) is one of the challenging economic problem of the power utilities due to the ON and OFF status of the units. Indeed, in SCUC we should determine the status of the units for the day-ahead horizon. SCUC is a mixed integer linear problem (MILP), which is hard to solve. Hence, in this paper, a new evolutionary algorithm, known as the multiverse optimization algorithm is developed to solve the problem.

Keywords—Security constrained unit commitment, evolutionary algorithm, optimization

I. INTRODUCTION

During the past decades, unit commitment has been attracted lots of attentions due to significant progress in tools and methods. Indeed, these methods can overcome the complexity of the power grids problems. Unit commitment (UC) is one of the challenging problems due to integer variables within the problem. In fact, these variables are utilized to show the status of the units: 1 when unit is ON, and 0 when unit is OFF. This paper developed a new population based evolutionary algorithm to overcome the complexity of the unit commitment problem [1-8]. This method is known as the multiverse optimization algorithm and has some significant advantages such as high convergence speed and

lower operational costs, compared to the well-known techniques such as particle swarm optimization (PSO) and genetic algorithm (GA) [9-14].

II. Unit Commitment Formulations

In the UC problem, the main goal is to determine the status of the generation units sothat the total operation cost is minimized, as

$$min \sum_{\forall i}[C_i P_{it} I_{it} + SU_{it} + SD_{it}] \quad (1)$$

Here, *I* is a binary variable that can be zero or one and determine the status of unit *i* at time *t*. *SU* and *SD* are the startup and shutdown costs of the *i*th unit at time *t*.

Also, there exist some constraints associated with the problem. For instance, the capacity of the DGs should be within limits as

$$P_{it,min} \leq P_{it} \leq P_{it,max} \quad (2)$$

Here, *P* is the output power of DGs.

In addition, the limitation on the ramp up and down of generators are as:

$$P_{it} - P_{i(t-1)} \leq RU_i \quad (3)$$

$$P_{i(t-1)} - P_{it} \leq RD_i \quad (4)$$

Where:

RU_i and RU_i are the ramp up and ramp down rates of the *i*th generation units, respectively.

Finally, the minimum up and down time limits are considered as:

$$T_{(on)it} \geq UT_i(I_{it} - I_{i(t-1)} \quad (5)$$

$$T_{(off)it} \geq DT_i(I_{i(t-1)} - I_{it} \quad (6)$$

Where:

UT_i and DT_i are minimum up and down rates of the *i*th unit.

$T_{(on)}$ and $T_{(off)}$ represents the number of successive on and off hours.

This paper utilized a new evolutionary algorithm known as the multiverse evolutionary algorithm. This method is taken form [15]. Compared to the well-known methods such as particle swarm optimization (PSO) and genetic algorithm (GA), the proposed technique has higher accuracy and speed [16].

III. RESULTS

In this section, the proposed technique is tested on the UC problem. The problem has 3 units. Also the load demand is shown in Fig 1.

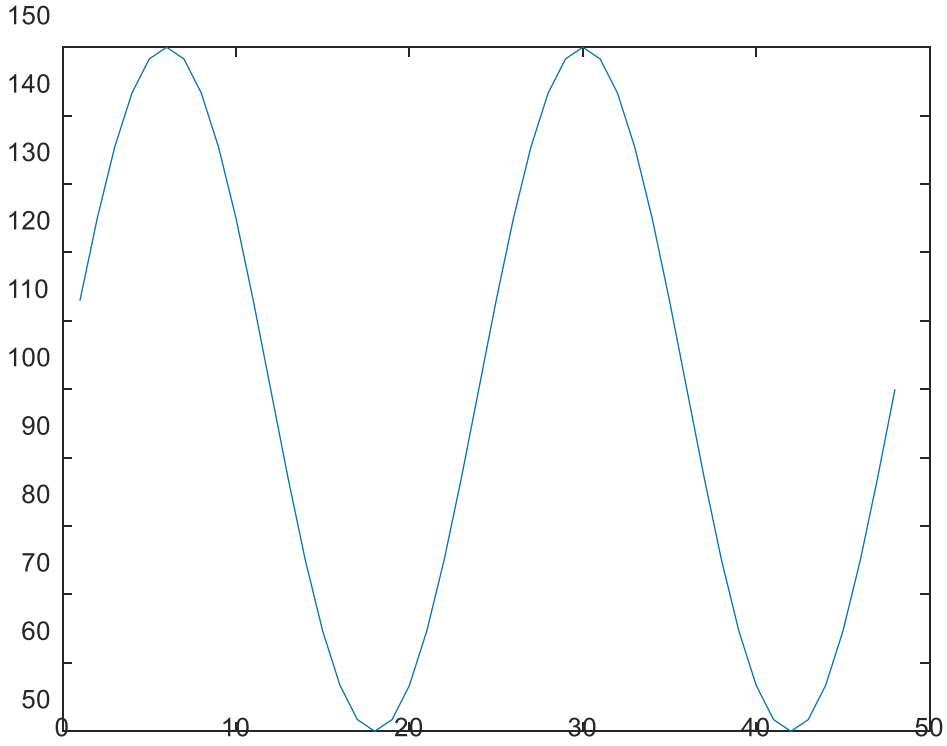

Fig. 1. Load demand for the next 48 hours

The optimal output power of generation units is shown in Fig. 2. The results show that the cheapest unit are committed than others, means economic consideration.

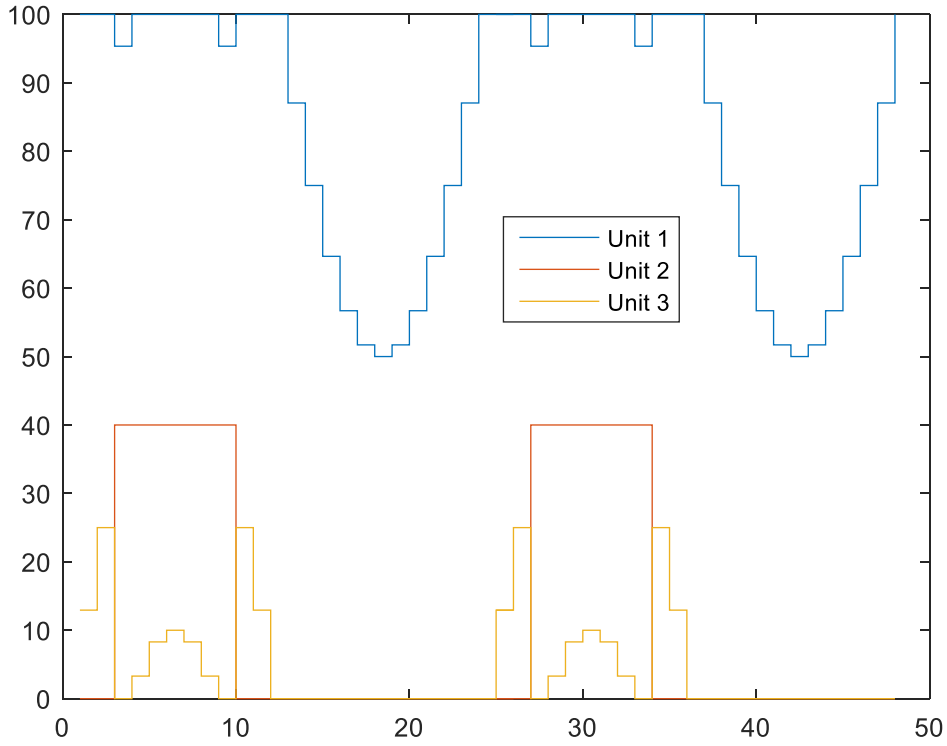

Fig. 2. Output power of the generation units

Table I compares the optimal operation cost and speed of the several methods. Based on this table, the proposed method has less cost, as well as higher speed.

Table I

Cost of operation for several methods

	cost ($)	Convergence (s)
PSO	4534.2	14.3
GA	4843.4	10.9
Proposed method	4123.9	6.8

IV. Conclusion

In this paper, one of the most challenging problems of the power system, known as the unit commitment is solve by the new evolutionary algorithm. This algorithm known as the multiverse optimization algorithm and it has some significant merit from both economic and speed perspectives, compared to the PSO and GA algorithms.

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