

Controlling Effect of HSABC Algorithm on the Unit Commitment of Power System Operation

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Abstract

The total operating cost may be expressed in an Economic Power System Operation (EPSO). Technically, this fee is presented to meet total demand for load by individual generating unit costs based on the schedule of engaged energy outputs (EEO). The minimum operating cost is currently achieved by considering economic and emission dispatches, which are made up of the problem of a combined economic and emission dispatch (CEED). The latest artificial intelligent calculation, Harvest Season Artificial Bee Colony Algorithm, is used to identify EEO using the IEEE-62 bus system based on a low cost of CEED. The results of the simulation show that HSABC has short time and rapid convergences. Space areas have various impacts on the performance of HSABC Algorithm on the CEED.

Keywords

Artificial bee colony, economic dispatch, emission, combined economic and emission dispatch

INTRODUCTION

The Economic Power System Operation (EPSO) based Economic Dispatch (ED) recently considers global warming caused by pollutant emissions from thermal plants into the air. EPSO is also used to cover an environmental penetration for the pollutants. These pollutants are released in [1]–[5] different kinds, such as CO, CO₂, SO_x and NO_x, through combustion of fossil fuels. The EPSO is currently becoming complex in considering emission dispatch (EmD) in operational terms. In practice an EPSO is run using cost-effective solutions to supply power from generator sites to demand areas for load. These strategies are used to determine the total minimum cost for EPSO to satisfy total demand for load at a certain time. A minimum total cost is obtained in particular.

Many methods were introduced with traditional and evolutionary methods for solving a combined economic and emission dispatch (CEED) problems. Evolutionary methods were composed to try to create different algorithms for the natural phenomena. These methods are often used to calculate CEED problems as traditional methods are used in large systems and multi-dimensional spaces [1]–[4]. Genetic algorithms are the most popular evolutionary method for a couple of years and are inspired by a natural evolutionary phenomenon. Artificial bee colony algorithm is recently the newest evolutionary method. This method, based on the drilling behaviour, was proposed in 2005. ABC's latest generation is an algorithm induced in this paper for the determination of the engaged energy outputs (EEO) called in the Harvest Season Artificial Bee Colony (HSABC) Algorithm. By using the IEEE power system model, the HSABC is used on the CEED problem.

HSABC ALGORITHM

The HSABC is inspired by the nature of a harvest season for flowers. Many of the flowers located randomly in certain places in the harvest season are expressive in multiple food sources (MFS) in HSABC. In this space area (SA), bees are being explored to look for food sources. Bees can fly randomly from a selected current food source to other locations to exploit a large number of food sources while they forage for food. The first food source (FFS) and other food sources (OFSs) are included in the HSABC. A harvest operator (ho) of the FFS is responsible for each position of OFS [5], [6].

The HSABC contains three agents to explore the SA, bees, scout bees and bees. Each agent has different tasks and the best food as an optimal solution is obtained. The definition of the employed bee is to look for a nearby source of food in the SA. The solution to the problem is possible from every food source selected. The best food is selected for the best solution for a bee viewers. Based on the likely value of each nectar quality, this bee chooses a food source. A scout bee is used to explore sources of food for renounced values.

A number of MFSs are prepared for each fodder cycle to provide candidate food for the SA. Food for HSABC products is preceded by an FSS search, and is accompanied by OFSs in various locations in the SA. As candidate solutions, an initial population is produced and randomly developed by taking objective constraints into account. The number of parameters to be optimized for each solution is matched. The quality of nectar is assessed carefully when the probability is measured regularly for each source food. Each candidate food position the FSS is used to search and the OFSs are followed by all positions.

ECONOMIC OPERATION

The minimum total operating cost of EPSO is technically presented by the CEED. The CEED problem considered operational limitations are used for optimization of payment for the EEO of generating units [7]–[9]. Basically, the CEED problem of the EPSO takes into account the total cost of ED. CEED also includes pollutant emissions. Every generator's pollutant discharge is associated with EmD's function which is directed to reduce the total emission of pollutants.

At present, it is important in EPSO to minimize total fuel costs and reduce total pollutant emissions. CEED has an objective function that uses ED and EmD problems with penalties and compromised factors. The rate coefficient of each generator unit is shown at its maximum capacity output for a given load, each penalty factor. The ED and EmD contribution to CEED calculations is defined using a compromised factor [2], [7], [10], [11].

PROCEDURE

The IEEE-62 system is used as a sample power system model in these installations. This system shows 62 buses, 89 lines and 32 charging buses in Figure 1. Figure 1. This figure also shows where the generating units and load positions are located in the power system.

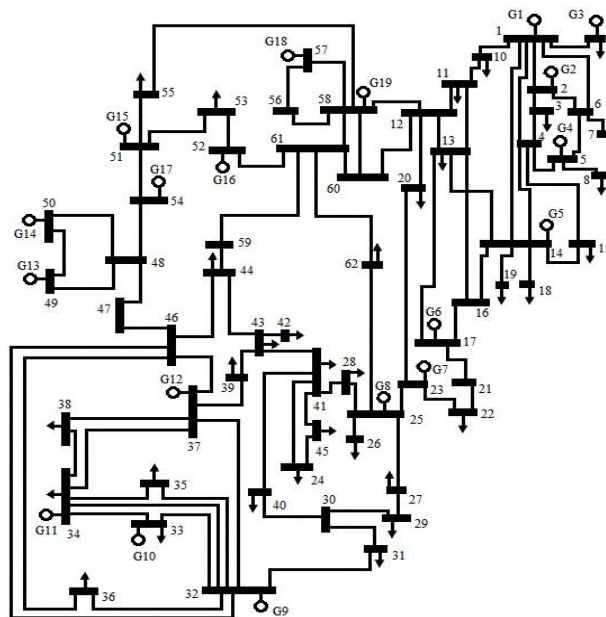


Fig. 1. One-line diagram of IEEE-62 bus system

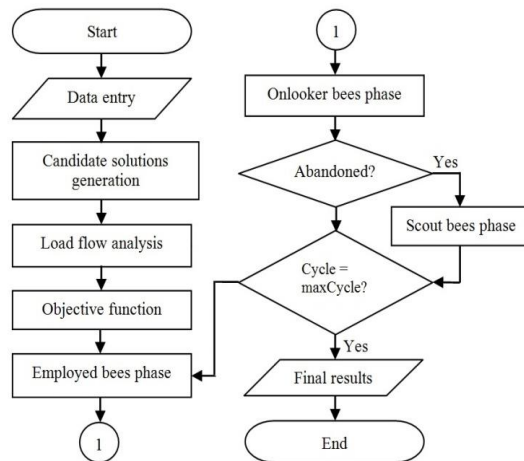


Fig. 2. Flow chart of HSABC's application

Figure 2 illustrates the main procedures of the HSABC request to determine the EEO of EPSO. This figure also describes sequence calculations based on an overall minimum EPSO cost for searching for the ideal solution. Three steps are included in the procedures of HSABC. The first step is the development of the objective CEED problem function, which is used to calculate the minimum total cost for each feed cycle. Second step is the composition of algorithms using bees, spectators and scout bees to find the best solution. The third step is to develop the program in terms of data input, CEED programs and algorithms in three categories of sub-programs.

The input data program consists of a defined input of parameters such as units for generation, transmission lines, loads and restrictions. The CEED program is designed in accordance with operational constraints to calculate an objective function and the number of CEED variable is associated with an examination of food source limits. The algorithm programme, which is based on HSABC hierarchies, is developed to look for a solution for the CEED problem. Three types of bee are involved in these programs to explore food sources in the SA and the programs to select the best food as the best solution for bee-keepers using the parameters.

RESULT AND DISCUSSION

These simulations are addressed in this section to determine the operational restrictions given in section 3 of EPSO's EEO. The HSABC is exhausted by three food sources and the SA is shown by four scenarios for 100%, 75%, 50% and 45%. A certain population for candidate foods that consider the power constraints of generating units is initialized for these simulations in Figure 3. In each food processing cycle the population is created for 50 G1 to G19 candidate solutions. Figure 4 illustrates HSABC convergence speeds for the identification of optimal solutions. These characteristics are carried out by means of 45%, 50%, 75% and 100% of the SA.

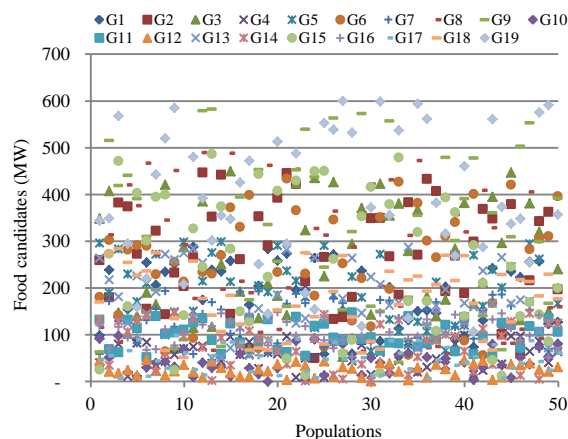


Fig. 3. Initial population

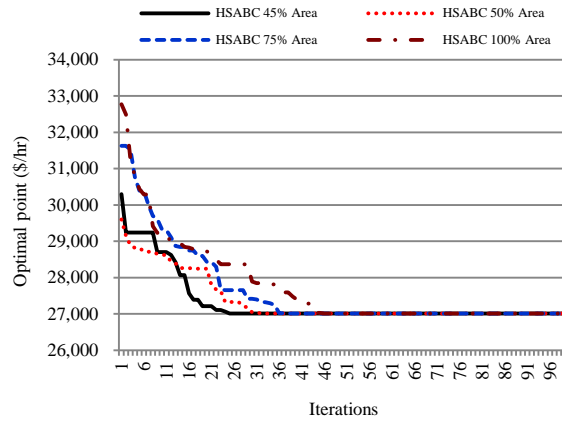


Fig. 4. Convergence speeds of HSABC

TABLE I
TIME CONSUMPTIONS OF HSABC

Algorithms	Min. iter.	Time of min. iter. (s)	Total time of 100 cycles (s)
HSABC 45% Area	25	3.31	12.91
HSABC 50% Area	32	4.43	13.02
HSABC 75% Area	43	7.63	19.27
HSABC 100% Area	48	10.86	22.03

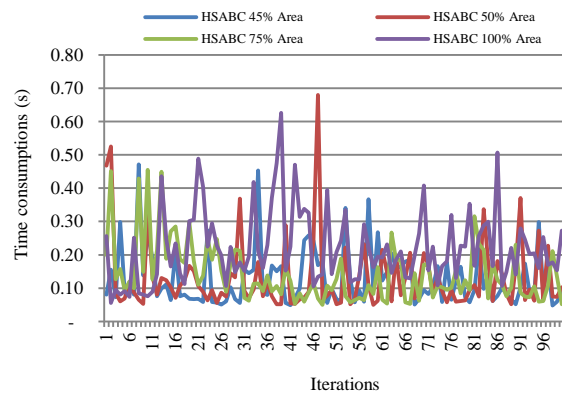


Fig. 5. Time consumptions of HSABC's computations

TABLE II
STATISTICAL RESULTS OF HSABC

Statistic Results	HSABC 45% Area	HSABC 50% Area	HSABC 75% Area	HSABC 100% Area
Max	30,299.16	29,601.37	31,625.36	32,773.61
Min	27,005.93	27,005.93	27,005.93	27,005.93
Range	3,293.24	2,595.44	4,619.43	5,767.68
Mean	27,319.18	27,361.65	27,625.08	27,767.72
Median	27,005.93	27,005.93	27,005.93	27,005.93
Mode	27,005.93	27,005.93	27,005.93	27,005.93
Std.dev.	725.08	652.78	1,146.61	1,212.39

It is known in Figure 4 that 45 percent of SA is faster than other HSABC convergence speed is. This feature is shown in 25 iterations to search for a minimum CEED solution after the first iteration is at \$30,299.16. 50per cent of the SA used by HSABC has been started on \$29,601,37 per hour and converge in 32 iterations to the minimum

value. HSABC has used 75% of SA for 43 iteration to achieve a minimum CEED result of \$27,005,93 per hour from the first iteration, compared to \$31,625,36 per hour. SA's largest size generates 48 convergence iters, and the initial cost of HSABC is \$32,773.61 per hour. Table II provides detailed statistical results for each HSABC using each SA size. For max and min points, the range, mean, median, modes and standard deviations, this table provides HSABC values.

Table I gives HSABC time consumption in each area with respect to the number of execution times for the designed programs during the search for minimum solutions. This table shows the time consumption to achieve the minimum total costs and to complete the program execution in 100 drilling cycles. The minimum amount of HSABC is searched in detail in 3.31 minutes with 45 percent SA. This calculation is performed within 12.91 minutes for 100 drilling cycles with different running times as Figure 5 shows.

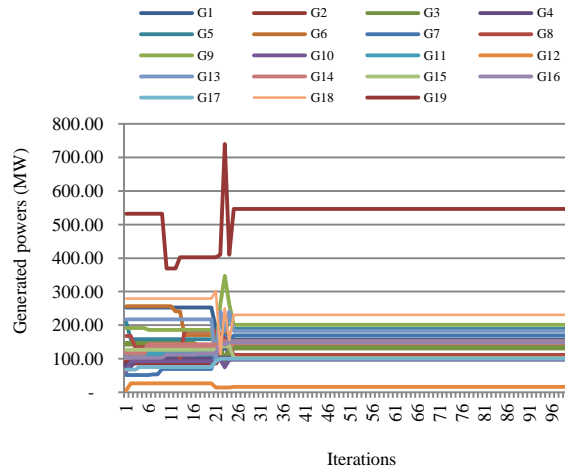


Fig. 6. Progressing powers of generating units

Figure 6 presents progressing computing powers of HSABC. This figure is made with 45% SA for G1 to G19 in order to satisfy total demand for load. This figure is also assessed through load flow analysis and output limitations. For a total power supply of 2912 MW of a total charge, the generators generate 3,049,83 MW. Total emissions of pollutant from generating units are around 14,474.45 kg/h. The overall payments of CPO power stations are \$54,011,85/h and the total costs for fuel are \$16,809,62/h, while the total cost of emissions is \$37,202.23/h.

CONCLUSION

This paper presents the algorithm of the Artificial Bee Colony Harvest Season (HSABC) for calculating committed generation unit outputs on the basis of a minimum total costs. The small size of SA results in better time consumption and speed of convergence by using different sizes of SA. In the case of SA applications, HSABC performance can be controlled through a size of harvest season area. Evaluations of limited discontinued solutions for future works are based on these projects.

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