Discussion on "A GA-API Solution for the Economic Dispatch of Generation in Power System Operation"

A. Srinivasa Reddy, *Member, IEEE*, and K. Vaisakh, *Member, IEEE*

The authors' effort in presenting a hybrid heuristic method combining real coded genetic algorithm and special class of ant colony optimization for economic dispatch (ED) problems is commendable [1]. The feasibility of the proposed method to solve ED is shown, by experimenting with four test systems considering 3, 6, 15, and 40 units with convex and nonconvex cost functions and also three benchmark functions. However, we would like to seek the authors' clarification regarding the following points.

1) In [1, Table V], the authors examined a three-generator test system with valve point loading effects. In the table title, smooth cost function is mentioned. After referring to [1, Fig. 3], it should be either nonsmooth or nonconvex cost function.
2) In [1, Table VII], the authors examined a six-generator test system with valve point loading effects, ramp rate limit, and prohibited operating zone constrains. The prohibited operating zones data for this test system referring to [2] and [3] (authors' [7] and [20]) are given in Table I. The power output of third unit ($P_3 = 225.75$ MW) by GAAPI method and third and fifth units ($P_3 = 223.11$ MW, $P_5 = 147.95$ MW) of RCGA falls in the prohibited operating zone. What is the authors' comment on this?
   From [1, Table VII], the total power output by GAAPI method is given as 1276.13 MW. But after adding the outputs of all generator units, total power is 1275.73 MW. This leads to power balance violation of 1.7 MW. How can the authors' justify this?
   Also the power losses of RCGA method are given as 12.07 MW. But, the losses, which are calculated from the given generation schedule, are found to be 12.70 MW. Is it a typing mistake? After referring to the references provided by [4] (author's [25]), it is not clear how authors developed the valve point loading effects data for this test system.
3) It is observed that there are some mistakes while using reference numbers [5], [17], and [21]. In Section II (p. 235), and Section IV (second, third, and fourth paragraphs), the reference number [5] should be changed to [7]. Similar to that in Section IV (third paragraph), the reference number [17] should be changed to [20] and there is confusion while locating the reference [21].
4) In Section IV, the authors quoted the minimum generation cost obtained so far for 15-unit test system as 32 751.39 $/h. But, from the literature [5], the minimum cost for this test system was 32 704. 4514 $ by CCPSO.

TABLE I
PROHIBITED ZONES DATA FOR SIX-UNIT TEST SYSTEM

Unit	Prohibited zones
1	[210 240] [350 380]
2	[90 110] [140 160]
3	[150 170] [210 240]
4	[80 90] [110 120]
5	[90 110] [140 150]
6	[75 85] [100 105]

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Discussion on "A GA-API Solution for the Economic Dispatch of Generation in Power System Operation"

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The authors are being commended for presenting an interesting idea to solve economic load dispatch problems through a combination of a special class of ant colony optimization called API and real coded genetic algorithm which they named as GA-API [1] approach.

In this paper, the authors have considered four test cases, out of which the second one is a 6-generator system having smooth and nonconvex fuel cost characteristics, prohibited operating zone, ramp-rate limits, and transmission loss for a system demand of 1263 MW.

These discussers have certain observations related to the data for this test case and seek some clarifications for proper appreciation of the paper:

The authors have mentioned that the input data for non-smooth case have been adapted from [2]. However, the input data could not be found in [2]. It would be beneficial if the authors could provide the correct reference or else the detailed input data including cost coefficients for ease of comparison.

Since the authors have compared in Table VII of their paper, the best results obtained by the proposed GA-API method with the results obtained by SOH-PSO [3], therefore, it has been presumed that they have adopted the input data for prohibited operating zone constraint from [3]. In that scenario, the output of 225.75 MW for third generator (in case of GAAPI) violates the prohibited operating zone constraint [210–240 MW] [3]. It would be interesting if the authors focus some light on it.

In Table VI of the paper, the authors have compared the best results obtained by them with those obtained by SOH-PSO [3] and other methods for the same test case having smooth cost function. However, in case of SOH-PSO, the power output of the generators as presented in the original paper [3] are completely different from those presented in [1, Table VI]. In [1, Table VI], the authors have reported that the generation cost obtained by SOH-PSO is 15446.02 $/hr. However, on calculation, the actual generation cost obtained by SOH-PSO is coming 15449.65 $/hr., for the power outputs as presented in the [1, Table VI]. It would be interesting if the authors could provide some suitable explanations for clarity and better understanding.

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Closure on "A GA-API Solution for the Economic Dispatch of Generation in Power System Operation"

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The authors would like to thank the commenters A. S. Reddy, K. Vaisakh, K. Bhattacharjee, A. Bhattacharya, and P. K. Chattopadhyay for their interest in [1] and their useful comments.

Below a clarification is provided for all the issues raised. The table numbering in the closure is the same as in [1].

1) The following editorial changes are necessary:
   a) The correct title in Table V should be "3-generator test system: best solution for a nonconvex cost function". In the original text, the word nonconvex was inadvertently replaced by smooth.
   b) The correct reference number in Section II-B5 and the 2nd, 3rd, and 4th paragraphs in Section IV should be [7] instead of [5]. Please note that references [17] and [21] mentioned by the commenters are correct as they appear in the paper.
   c) Corrections have been made to the sixth column in Table VI, where the values of the power output from [3] ([20] in the paper) were incorrectly entered. Please note, however, that only the power outputs of the units were incorrect, while the losses, the total power output, and the generation cost are correct.
2) Appropriate corrections have been made in Table VII to show the correct results after respecting the prohibited operating zones of unit 3. Please note that the new results do not affect the conclusions of the paper. The new results confirm that GAAPI outperforms the SOH-PSO and the RCGA solution.
3) Supplementary information regarding the cost characteristics of the 6-generator test system with valve point effect is presented in Table X (and also appearing in [4, Table I]). The numbering of the table is in sequence with the tables in [1].
4) The authors were not aware of the work in [2]. Based on this new information, indeed, the correct minimum cost for the 15-generator test system in Section IV is 32 704.45 $/h [2] and not 32 751.39 $/h. Please note that the minimum cost obtained in [1] is 32 732.95 $/h, which is comparable to the minimum cost obtained so far.

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TABLE VI
6-GENERATOR TEST SYSTEM: BEST SOLUTION FOR A SMOOTH COST FUNCTION

Unit output (MW)	LM	GA binary	RCGA	NPSO-LRS	SOH-PSO	GAAPI
P_1	447.00	456.46	474.81	446.96	438.21	447.12
P_2	173.50	168.26	178.64	173.39	172.58	173.41
P_3	264.00	258.68	262.21	262.34	257.42	264.11
P_4	138.50	132.66	134.28	139.51	141.09	138.31
P_5	166.04	170.97	151.90	164.70	179.37	166.02
P_6	87.00	89.10	74.18	89.01	86.88	87.00
Losses	13.00	13.13	13.02	12.93	12.55*	12.98
Total output	1276.00	1276.13	1276.03	1275.94	1275.55	1275.97
Generation cost ($/h)	15450.00	15451.66	15459.00	15450.0	15446.02	15449.7

(*) The loss value computed with the B-Loss formula (12.95 MW) is higher than the one given by the authors (12.55 MW) in [3].

TABLE VII
6-GENERATOR TEST SYSTEM: BEST SOLUTION FOR A NONCONVEX COST FUNCTION

Unit output (MW)	SOH-PSO	RCGA	GAAPI
P_1	419.64	491.65	421.54
P_2	188.16	179.91	179.85
P_3	198.15	249.06	250.09
P_4	150.00	103.25	137.31
P_5	200.00	198.72	199.73
P_6	120.00	50.00	87.91
Losses	12.95	13.78	13.44
Total power output	1275.95	1276.78	1276.44
Generation cost ($/h)	15896.73	15726.92	15516.13

TABLE X
6-GENERATOR TEST SYSTEM: COST COEFFICIENTS

Unit number	a	b	c	e	f
1	240	7.0	0.0070	300	0.0315
2	200	10.0	0.0095	150	0.063
3	220	8.5	0.0090	200	0.042
4	200	11.0	0.0090	100	0.084
5	220	10.5	0.0080	150	0.063
6	190	12.0	0.0075	100	0.084

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