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Economic Dispatch in Microgrid Using BAT INSPIRED ALGORITHM

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ABSTRACT: This paper present a method to solve the economic dispatch problem of distributed generators (DGs). The objective function is to minimize the fuel cost. Fuel costs are mainly dependent on type of DGs used in a microgrid. To achieve this goal, the economic dispatch (ED) problem and its related constraints were formulated. The constraints considered are power balance constraint and power generation limits of the DGs. The above problem is solved using nature bat inspired algorithm optimization and tested with 15 generation units system. From the results it can be said this proposed method yields better solution compare with other technique.

KEYWORDS: dispatch, fuel cost, constraints bat algorithm, optimization techniques, minimization

I INTRODUCTION

Electric power system need to be operated economically to make electrical energy cost-effective to the consumer in the face of constantly rising price of fuel, wages, salaries etc.,. Under deregulation and restructuring of power system electricity market becomes highly competitive. In the operation of power systems, the contribution from each load and from each unit within a plant must be such that cost of electrical energy produced is a minimum. Economic dispatch (ED) under mild assumptions on the cost functions of the generators when there are no line losses. The ED process periodically reallocates the total power among generators to minimize total cost. In fossil fuel price as well as sharp increase in the capital cost of new central generating plant, there is a focused attention on alternate generating system with higher efficiency of energy use.

Within distributed networks distributed generators (DG) are defined [1] as customer side of the network or electric power generation. The benefits of distributed generators are the system efficiency is improved, minimizing their maintenance costs, reducing the system power loss, minimizing the costs of losses and requiring less time for installation. Distributed generation scheme should achieve improvement in reliability, reduction of cost and environmental impact, integration and promotion of renewable resources.

Microgrids [2-4] are low voltage distributed networks that can operate either interconnected or isolated from the main distribution grid. Microgrids are systems that have at least one DG and associated loads and can be operated in parallel with utility grid or in islanded mode. Now a days Microgrid is the future grid and its benefits primarily focus on improving local security, reliability and robustness to meet the requirement of higher level of supply. Micro grids, with its decentralized electricity generation combined with on-site production of heat. It could be provide reliable and quality power as well as heat to its consumers.

The optimization of a microgrid has important differences from the case of a large power system and its conventional economic dispatch (ED) problem. This paper proposes formulations of the ED problem for microgrids and its related constraints, which yield the fuel cost minimization during grid operation. The dispatch problem is typically formulated as a multivariable constrained optimization problem [5-7]. Fuel cost minimization plays a predominant role in improving the efficiency of electric power system. Fuel cost minimization in microgrid is one of the important optimization problems to be addressed for good operating efficiency of microgrid. It can be minimized by optimal placement of DG in microgrid.

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Batsuse frequency tuning and parameter control to influence exploration and exploitation [8]. When compared with the above mentioned evolutionary algorithms, BIA produces better optimal solution and has faster convergence. The echo location behavior of micro bats can be formulated in such a way that it can be associated with the objective function to be optimized and this makes it possible to formulate new optimization algorithms.

II PROBLEM FORMULATION

Fuel cost minimization in microgrid is one of the optimization problems. Economic load dispatch [9] defined as the operation of generation facilities to produce energy at the lowest cost to reliably serve consumers, recognizing any operational limits of generation and transmission limits.

A. Economic load dispatch (ED) problem

The primary objective of economic load dispatch is to minimize the fuel cost (F_C), while satisfying the power balance and generation limits of the units.

It can be formulated as follows

$$Min\ F_C(P_{G_m}) = \sum_{m=1}^{k}(a_m P_{G_m}^2 + b_m P_{G_m} + c_m) \quad (1)$$

Here F_C is the fuel cost, P_{G_m} - Real power generation, a_m, b_m and c_m is the cost coefficients.

Above optimization is done subject to following constraint.

i) Power balance constraint:

In power balance constraint total generation of all DGs must be equal to total power demand.

$$\sum_{m=1}^{k} P_{G_m} = P_D$$

Where P_D is the real power demand

ii) Real power generation limit:

$$P_{G_m(\min)} \le P_{G_m} \le P_{G_m(\max)}$$

Each generating unit should not operate above its rating or below some minimum generation. This minimum value of real power generation is determined from the technical feasibility.

III BAT INSPIRED ALGORITHM

Bat inspired algorithm is based on the echo location behavior of micro bats with varying pulse rates of emission and loudness. Each virtual bat flies randomly with a velocity at position (solution) with a varying frequency or wavelength and loudness. As it searches and finds its prey, it changes frequency, loudness and pulse emission rate. Selection of the best continues until certain stop criteria are met. BIA considered as a combination of the standard particle swarm optimization and intensive local search controlled by the loudness and pulse rate. Their loudness and emission rates will be updated only if the new solutions are improved, which means bats is moving towards the optimal solution.
The pseudo code of bat algorithm is given below

Objective function f(x), $x=(x_1, x_d)^T$
Initialize the bat population $x_i (i=1, 2, ..., n)$ *and* v_i
Define pulse frequency f_i *at* x_i
Initialize pulse rates r_i *and the loudness* A_i
while(t<Max number of iterations)
Generate new solutions by adjusting frequency,
and updating velocities and locations/solutions
    if(rand>r_i*)*
    Select a solution among the best solutions
    Generate a local solution around the selected best solution
    end if
    Generate a new solution by flying randomly

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if(rand<A_i & $f(x_i) < f(x_*)$)
Accept the new solutions
Increase r_i and reduce A_i
end if
Rank the bats and find the current best x_*
end while
Postprocess results and visualization

Steps for BatInspiredAlgorithm

Following steps for BIA is explained below,

1. Define the initial population of bats w_m (m=1,2…..,b) to search for the optimum solution, where b is the number of bats.
2. Initialize the velocity for all bats according to the maximum value. This parameter will allow moving all bats with respect to the best positioned bat.
3. Consider the pulse rates and loudness of bats at each position. This will initialize the pulse rates a_i and loudness B_i in order to select the bats that move to the best solution. a_i value is changed between 0.4 and 0.7 and B_i value is changed between 0.4 and 0.8.
4. Evaluate the objective function of each position and select the bat with the minimum power losses or best positioned.
5. **While** (t < max iter)
   Generate new solutions by adjusting f_m
   Update velocities and solutions
   $$f_m = f_{\min} + (f_{\max} - f_{\min})\gamma$$
   $$v_m^i = v_m^{i-1} + (w_m^i - w_*) f_m$$
   $$w_m^t = w_m^{t-1} + v_m^t$$
   if (rand>a_i)
   Select a solution among the best solutions
   Generate a local solution around the selected bestsolution
   $$w_{new} = w_{old} + \xi B^t$$
   end
   Generate a new solution by flying randomly
   if (rand <B_i&f (w_m) <f (w_m)
   Save the new solution
   Increase a_i and reduce B_i
   end
   Find the current best w_*
   end while
6. While time step (t) is smaller than the maximum number of iteration,
   - Generate new solution of bats by adjusting frequency and velocity. Bats can move from one bus to another in the search of the best solution.
   - If the a_i is equal to a random number (ξ) between -1 and 1, generate new solutions around the best. Some bats join the search near the best solution. Bats can fly randomly to search for new size and position. Evaluate new solutions and find power losses for each position of the bats.
   - If a random number (ξ) is greater than the B_i and new solution is smaller than the best solution save the new best solution. The value of $B_i$can be reduced and a_i can be increased to find better solutions.
7. If t is greater than or equal to maximum number of iteration, stop the process otherwise go to step 6

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IV RESULTS AND DISCUSSIONS

Proposed BAT inspired algorithm has applied for economic dispatch problem in microgrid. Here, results obtain by this method is compared with other technique for the same the test systems.

DG	Cost data			Output limit(kw)	
	c_g	b_g	a_g	Max	Min
G1	13.526	0.1032	0.0001	300	35
G2	4.0797	0.0792	0.0005	100	20
G3	7.7657	0.0656	0.0004	150	30
G4	1.8505	0.0689	0.0009	80	10
G5	1.091	0.0301	0.0011	100	20
G6	7.5957	0.0346	0.0002	250	60
G7	1.8505	0.0689	0.0009	80	10
G8	4.0797	0.0792	0.0005	100	20
G9	2.4047	0.0134	0.0009	120	30
G10	2.4047	0.0134	0.0009	120	30
G11	11.526	0.1032	0.0001	300	35
G12	6.4976	0.1164	0.0002	150	20
G13	5.4976	0.1164	0.0002	150	20
G14	2.0171	0.0486	0.0013	75	10
G15	2.5442	0.1189	0.0003	100	10
Total				2175	360

Table 1.-Unit input data

A system with 15 distributed generators is considered to test the proposed method. The load demand taken is 1500 Kw.

The table 2 gives the power output of each distributed generators for different technique like conventional method, Direct Search Method (DSM) and proposed BAT inspired algorithm

DGs Power	Conventional method(Kw)	DSM(Kw)	BAT(Kw)
P1	229.5779	219.5668	219.5557
P2	69.9156	69.8156	69.8267
P3	104.3495	102.3245	102.3254
P4	44.5642	46.5892	46.4883
P5	54.0980	64.1081	64.2081
P6	250.0000	240.000	239.1000
P7	44.5642	44.5643	45.6643
P8	69.9156	68.4157	66.4257
P9	75.3975	76.8864	78.8764

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P10	75.3975	85.4975	85.4975
P11	229.5779	224.5900	224.5902
P12	81.7890	79.7890	78.6780
P13	81.7890	79.7890	78.6780
P14	38.6598	43.3265	45.5487
P15	50.3593	54.6926	54.5704

Table 2.Power output of each units

The table 3 gives total power generated by all units and total cost for the power generation. From the table it is said when comparing with other method BAT inspired algorithm give optimum cost total cost and more power generation.

Variable/Method	Conventional method	DSM	BAT
Total Power Generated(Kw/hr)	1499.9852	1499.9964	1500.0084
Total Cost($/hr)	240.6903	240.4974	239.9936

Table 3. Total cost by using different technique

This reduced total cost will minimize the usage of fuel when non-renewable fuel like diesel, micro turbine and fuel cells are used.

The change in power output of each unit for different technique is shown in table 2. The change in power output of generators is towards the low cost generating unit from high cost generating units. It can be said that for 1500kw load the cost reduces by 0.02% form the conventional method. When load and generation of power from distributed generators are in megawatts (MWs) range then cost will reduces by more percent. This will reduce the customer electricity bills and improve the distributed generators companies financial problem.

V CONCLUSION

The problem is tested with the proposed method and the results are compared with other techniques. From the proposed method, power generation is more from the low fuel cost units. Compared with other techniques this method is a promising alternative for economic dispatch problem with applied for very large power generation units.

REFERENCES

[1] Ackermann T, Andersson G, and Soder L, (2001),"Distributed generation: a definition," Electrical Power System Research., 57 (3): 195-204.
[2] Lasseter R H, (2002),"Microgrids", *Proc.IEEE-PES Winter Meeting*, vol. 4, pp. 305-308.
[3] Asano H, Hatziargytiou N, Iravani R, and Marnay C, (2007). "Micro-grids," *Proc. IEEE Power and Energy Mag.*, vol. 5, no. 4, pp. 78–94.
[4] Liang H and Zhuang W (2014), "Stochastic Modeling and Optimization in a Microgrid", Journal Energies, vol. 7, pp. 2027-2050. B. Chowdhury and S. Rahman, "A review of recent advances in economic dispatch," *IEEE Trans. Power Syst.*, vol. 5, no. 4, pp.1248–1259, Nov. 1990.
[5] B. Chowdhury and S. Rahman, "A review of recent advances in economic dispatch," *IEEE Trans. Power Syst.*, vol. 5, no. 4, pp.1248–1259, Nov. 1990
[6] A. Mohammadi, M. Varahram, and I. Kheirizad, "Online solving of economic dispatch problem using neural network approach and comparing it with classical method," *in Proc. IEEE Int. Conf. Emerging Technol.*, 2007, pp. 581–586.
[7] Yang X.-S. (2010). "A New Metaheuristic Bat-Inspired Algorithm," *in Nature Inspired Cooperative Strategies for Optimization (NICSO 2010)* SE - 6, vol. 284.
[8] Energy policy Act 2005.