Economic Analysis of Distributed Generation System In Railway Rake Using Firefly Algorithm

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Abstract- *Distributed generation with renewable energy resources is gaining importance in modern power systems for its environmental beneficiaries. In this work, decentralized generation system is introduced using distributed renewable energy resources considering its economic feasibility, a comparative study has made to find the optimal power operation and optimum installable capacities of distributed energy resources for minimum energy cost. Firefly algorithm is applied for some benchmark function to highlight the efficiency of algorithm. Comparisons were done by using*

Keywords- firefly algorithm, Economic load dispatch

I. INTRODUCTION

Distributed generation play an important role in modern power system. The distributed energies are stored in the form of small grid-connected device known as distributed energy resources. The distributed energy resource system use renewable energy sources, including small hydro, biomass, biogas, solar power, wind power and geothermal power. Distributed generation refers total power generation at the point of consumption. In this paper a proposal is introduced to implement distributed energy in railway rake maintainance depot. Considering its economic feasibility and also to find optimal power operation for minimum energy cost. Distributed generation is an approach that employs small-scale technologies to produce electricity close to the end users of power. In several cases, distributed generators can provide lower-cost electricity and higher power reliability and security with fewer environmental consequences than can traditional power generators. In contrast to the use of a few large-scale generating stations located far from load centers. The approach used in the traditional electric power paradigm. DG systems employ numerous, but small plants and can provide power onsite with little reliance on the distribution and transmission grid. Distributed generation (DG) is often produced.

II. IMPLEMENTATION OF ECONOMIC DISPATCH PROBLEM

A.Problem formulation

The objective of economic load dispatch of electric power generation is to schedule the committed generating unit outputs so as to meet the load demand at minimum operating cost while satisfying all units and operational constraints of the power system. The economic dispatch problem is a constrained optimization problem and it can be mathematically expressed as follows:

$$min F_T = \sum_{n=1}^{n} F_n(P_n)$$

where F_T: total generation cost (Rs/hr) n: number of generators P_n: real power generation of n^{th} generator (MW) $F_n(P_n)$: generation cost for P_n Subject to a number of power systems network equality and inequality constraints. The proposed algorithm is strictly proved by using matrix perturbation theory. The effectiveness and correctness of the proposed fully distributed algorithm is verified by simulation studies The proposed algorithm is strictly proved by using matrix perturbation theory. The effectiveness and correctness of the proposed fully distributed algorithm is verified by simulation studies.

B. System Active Power Balance

For power balance, an equality constraint should be satisfied. The total power generated should be the same as total load demand plus the total line

$$P_D + P_L - \sum_{n=1}^{n} P_n = 0$$

where P_D: total system demand (MW) P_L: transmission loss of the system (MW).

C. Network losses

Since the power stations are usually spread out geographically, the transmission network losses must be taken into account to achieve true economic dispatch. Network loss is a function of unit generation. To calculate network losses, two methods are in general used.One is the penalty factors method and the other is the B coefficients method. The latter is commonly used by the power utility industry, where B_{mn} constants are called B coefficients or loss coefficients . Economic dispatch problem in islanded microgrid is to minimize the total cost of distributed generators,while satisfying the supply and demand constraints and generation constraints. Based on the distributed structure of microgrid systems, a distributed solution of economic dispatch .islanded microgrid systems is proposed to calculate the optimal active power generations for each generator.The total cost of operation includes the cost of labour, fuel cost, maintenance and supplies. Generally, costs of labour, supplies and maintenance are fixed percentages of incoming fuel costs. The throttling losses are large when a valve is just opened and small when it is fully opened. The power output of fossil plants is increased sequentially by opening a set of valves to its steam turbine at the inlet. B T G Boiler Turbine Generator Fuel Input. The cost is usually approximated by one or more quadratic segments. The fuel cost curve may have a number of discontinuities. Within the continuity range the incremental fuel cost may be expressed by a number of short line segments or piece-wise if the cost represents the operation of an entire power station, and so that cost has discontinuities on paralleling of generators.

D. Algorithm For Economic Dispatch

- ✓ Initialization: Input data such as; number of plants, total load demand, generator limits, cost curve coefficients, iteration limit and tolerance.
- ✓ Start counter.
- ✓ Calculate power value for each plant using Equation .
- ✓ Check if iteration limits is exceeded. If yes, inform user of non-convergence and stop
- ✓ Check if Power value for plant is less then set limit. If yes, set power value to lower limit, increment counter .
- ✓ Check if Power value for plant is more than set limit. If yes, set power value to upper limit, increment counter .
- ✓ Sum up Power for all plants and calculate the power loss .
- ✓ Calculate net power.
- ✓ If absolute value for net power is less than set tolerance level, Display calculated power value, incremental cost value and stop.
- ✓ If net power is greater than zero, Reduce the value of the incremental cost, increment counter . Else, increase the value of the incremental cost, increment counter .

III. FIRELY ALGORITHM

A. Firefly

The Firefly Algorithm (FA) is a meta heuristic, nature inspired, optimization algorithm which is based on the social (flashing) behavior of fireflies, or lighting bugs, in the summer sky in the tropical temperature regions. It is based on the swarm behavior such as fish, insects, or bird schooling in nature. In particular, although the firefly algorithm has many similarities with other algorithms which are based on the so called swarm intelligence, such as the famous Particle Swarm Optimization (PSO), Artificial Bee Colony optimization (ABC), and Bacterial Foraging (BFA) algorithms, it is indeed much simpler both in concept and implementation. Furthermore, the algorithm is very efficient and can outperform other conventional algorithms, such as genetic algorithms, for solving many optimization problem, a fact that has been justified in a recent research, where the statistical performance of the firefly algorithm was measured against other well-known optimization algorithms using various standard stochastic test functions.

Its main advantage is

- uses mainly real random numbers,
- based on the global communication among the swarming particles

B. Characteristics

The firefly algorithm has three particular idealized rules which are based on some of the major flashing characteristics of real fireflies. These are the following:

- ➢ All fireflies are unisex, and they will move towards more attractive and brighter ones regardless their sex.
- ➢ The degree of attractiveness of a firefly is proportional to its brightness which decreases as the distance from the other firefly increases due to the fact that the air absorbs light. If there is not a brighter or more attractive firefly than a particular one, it will then move randomly.
- ➢ The brightness or light intensity of a firefly is determined by the value of the objective function of a given problem. For maximization problems, the light intensity is proportional to the value of the objective function.

C. Attractiveness

In the firefly algorithm, the form of attractiveness function of a firefly is the following monotonically decreasing function

$$\beta(r) = \beta o^* \exp(-\gamma rm), \text{ with } m \geq 1, \qquad (1)$$

where, r is the distance between any two fireflies,
βo is the initial attractiveness at r = 0, and
γ is an absorption coefficient which controls the decrease of the light intensity

D. Movement

The movement of a firefly i which is attracted by a more attractive (i.e., brighter)firefly j is given by the following equation

Xi= xi+ β0 * exp (−γ r_{ij} ^2) * (xj – xi)+a * (rand – ½) (2)

where the first term is the current position of a firefly, the second term is used for considering a firefly's attractiveness to light intensity seen by adjacent fireflies, and the third term is used for the random movement of a firefly in case there are not any brighter ones. The coefficient α is a randomization parameter determined by the problem of interest, while rand is a random number generator uniformly distributed in the space [0,1]. As we will see in this implementation of the algorithm, we will use β0 =1.0, α ∈ [0, 1] and the attractiveness or absorption coefficient γ = 1.0, which guarantees a quick convergence of the algorithm to the optimal solution.

E. Pseudocode For Firefly Algorithm

Step 1: Define objective function f(x)
Step 2: Input the algorithm parameters

- Randomness (α)
- Attractiveness (β)
- Light absorption coefficient (ϒ)
- Random reduction parameter (Ƨ)
- Number of fireflies(n)
- Maximum iterations(t),and
- Stopping criteria

Step 3: Generate intial population of fireflies x_i(i=1,2,3…….n) randomly generated.
Step 4: Evaluate the light intensity(I_i).
Step 5: While(t≤max.gen)
For i=1:n(for all fireflies)
For j=1:n(for all fireflies)
Evaluate and generate new solution and update light intensity
End for I loop
End for j loop
Rank the fireflies and display the best
Step 6: Post process result and visualization
Step 7: Find the firefly with high light intensity among all fireflies.
Step 8: Plot the increase in light intensity
Step 9:Plot the objective with respective with time
Step 10: Stop
In this problem the generation limits of generators are the stopping criteria of the algorithm. It has the advantage of

- Ease of implementation
- best acuracy

IV. RESULTS

A. Comparison Result Between Various Algorithms

Fig:4.2 COMPARISON RESULT OF VARIOUS ALGORITHM

	AG	PSO	FFA	BA
P1	21.4220	29.2410	28.199	28.2911
P2	23.6700	13.879	9.654	10.0000
P3	118.0564	118.9667	118.854	118.9568
P4	118.3270	118.3270	118.310	118.6753
P5	230.5502	230.7553	230.662	230.7668

The objective of economic load dispatch of electric power generation is to schedule the committed generating unit outputs so as to meet the load demand at minimum operating cost while satisfying all units and operational constraints of the power system..

Economic dispatch (ED) is the operation of generation to produce energy at the lowest cost by fulfilling the demand within several limits. This is not an easy task since there are a lot of factors need to be considered especially in the large interconnected power system.

Fig:4.1 TEST RESULT OF FIREFLY ALGORITHM FOR SIX UNIT SYSTEM

Pd	firefly algorithm					
	P1	P2	P3	P4	P5	P6
600	23.8587	10.0000	95.6376	100.7030	202.8428	181.1953
650	26.0690	10.0000	107.2678	109.6703	216.7651	196.9558
700	28.2911	10.0000	118.9568	118.6753	230.7668	212.7419
750	30.4787	11.2272	130.4517	127.5111	244.4575	228.1844
800	32.5877	14.4827	141.5491	136.0426	257.6603	243.0085

V. CONCLUSION

The results obtained by applying the proposed algorithm were compared to those obtained by AG, PSO and BA. The Firefly algorithm has superior features, including quality of solution, stable convergence characteristics and good computational efficiency. The comparison shows that firefly algorithm performs better than the mentioned methods. Therefore, firefly optimization is a promising technique for solving complicated problems in power system.

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