ECONOMIC OPTIMIZATION OF MICRO GRID BY RUNNER ROOT ALGORITHM (RRA)

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The main focal point of this paper is to solve the economic optimization problem of micro grids using advanced algorithm called RRA (Runner Root Algorithm) which is based on intelligence behavior of strawberry plants. Further, this heuristic technique (RRA) is able to solve the complexity of various constraint parameters involve like emission coefficients, decision variables and controlling parameters of micro grids. In this paper, proposed methodis applied on standard data of power system and the results obtained in RRA (Runner RootAlgorithm) method are being compared with other optimization techniques. By comparing the results of optimization, RRA method is able to achieve the optimal economic value of hybrid power system.

Keywords*: Biological Optimization, Runner Root Algorithm, Micro grid, Economic Load Dispatch*

1. INTRODUCTION

In today's world, the application of Micro grids leads to enhancement of electrical power technology that play very important role in solving the economic optimization problem of modern power systems. The modern Micro grid power system acts like a small nodal center that is used to the distribute the electrical power of an area in most efficient way along with minimization of cost factor where it is located. The micro grid is the combination of various distributed generating (DG) units along with energy storage units that ensure the contentmentof electrical demand to customer. In Micro grid system, there are many progressions in constructions starting from basic conventional generators to renewable energy units (such as solar and wind power units) are made to deliver the required amount of electrical energy in most efficient way [1]. The various energy storage devices that can be used in Micro grids areadvanced batteries and pumped storage units which are being controlled and stabilized by performance of various operations like ESSs technique. The main benefit of using microgrid is that it can be used to distribute the load to remote as well as local areas. The problem of economic load dispatch (ELD) in Micro grid can be solved effectively by applying the various optimization techniques that are based on intelligent behavior of nature.

These Meta heuristic helps to deal out the power load among the generating units in such a way that overall costing factor can be easily be reduced along with fulfillment of environmentalas well as economic conditions. Basically, the optimization techniques are classified into two categories and that are conventional and modern techniques that are used in the economic consideration of power grids. The conventional techniques also called traditional techniques are based mainly on

mathematical differential equations while modern techniques are computational based intelligent algorithms that are inspired from various natural phenomena.Traditional techniques involve the Dynamic Programming methods like Lambda iteration method while biological algorithms include the techniques like IWO (Intelligent WaterOptimization), BFO (Bacterial Forging Optimization), and CRO (Coral Reef Optimization) [2-3].

The Micro grid is combination of renewable energy resources (RES) that are being used forthe development of hybrid model along with allocation of the adjusted power value among theelectrical distributing units. Therefore, the problem of Economic Load Dispatch (ELD) ofMicro grid contains various uncertain restrictions and constrictions that need to be optimized In this paper, main focus has been devoted to solving of ELD problem in hybrid structure of micro grid shown in figure 1 by using new biological based optimization technique called RunnerRoot Optimization for controlling the cost function by controlling the various parameters like operating cost function, objective function, forecasted values of renewable energy sources (RES),power balance constraints and finally results are being compared with the other optimization techniques.

Figure 1: Basic structure of proposed Micro grid

The paper is arranged as follow. Section II provides an inclusive detail about formulation of objective function i.e. single objective ELD (Economic Load Dispatch) problem having position and structure constraints along with mathematical modeling of various distributed generation (DG)sources. Section III gives the information about optimization technique which is biological basedalgorithm that is applied to understand the working principle of new hybrid structure of micro grid in order to solve the optimization problem of power market. Section IV is about results of proposed technique with its computational value.

2. ECONOMIC MODELLING FOR PROPOSED STRUCTURE OF MICROGRID (FORMULATION OF PROBLEM)

GENERATOR FUEL COST FUNCTION

ECONOMIC LOAD DISPATCH

The main objective in economic dispatch problem is to minimize the generation cost of fuel by distributing the power among units equally. The economic dispatch problem of power market canbe formulated mathematically as [4]:

$$\text{MIN COST } F_T = \sum_{i}^{N_G} F_i(P_i) \tag{1}$$

Where $F_i(P_i)$ is the cost function and it is evaluated by quadratic function of output power as:

$$F_i(P_i) = \sum_{i=1}^{N_G} \{ a_i P_i^2 + b_i P_i + c_i \} \tag{2}$$

N_G is the number of generating units, P_i is power output of generating unit, a_i, b_i , c_i are fuel cost coefficients

RENEWABLE ENERGY SOURCES (RES) INTEGRATION:

The integration of renewable energy sources (RES) help to reduce fuel cost as well as emission cost of conventional energy resources in the micro grids. The combination of RES consists of photovoltaic generator and wind generator. These sources are also called clean energy sources because they neither emit the harmful gases to environment nor incur any fuel cost [5]. During integration with conventional systems in the micro-grids, these renewable energy sources (RES) have maintenance or installation cost whose cost function is given by

$$F(P_{RES}) = P_{RES}(AC.I^P + G^E) \tag{3}$$

Where P_{RES} is the output power of renewable energy resources, AC is the Annuitization Coefficient, I^p is the ratio of investment cost of power in \$/KW, G^E is the operational and maintenance cost in \$/KW, The Annuitization Coefficient (AC) is calculated with formula

$$AC = \frac{r}{1-(1+r)^{-N}} \tag{4}$$

Where r is the interest scale and N is the investment duration in years.

ECONOMIC LOAD DISPATCH (ELD) EQUATION FOR PROPOSED MICROGRID

The total cost equation of economic load dispatch (ELD) for proposed micro grid is given by

$$F_T = \sum_{i=1}^{N_G} \left[\{ a_i P_i^2 + b_i P_i + c_i \} \right] + 547.7483 * P_S + 153.3810 * P_W \tag{5}$$

CONSTRAINT FUNCTION

i) Power unit constraints are given by:

$$P_i^{\min} \le P_i \le P_i^{\max}$$
$$P_{RES}^{\min} \le P_{RES} \le P_{RES}^{\max} \quad (6)$$

Where P is power generated by conventional as well as renewable energy resources units.

ii) Isolated type MG (micro grid)

No account of trading from the main grid

iii) Power balance equation

$$P_{LOAD} = P + P_{SOLAR} + P_{WIND} \quad (7)$$

3. Runner Root Algorithm (RRA)

The Runner Root Algorithm (RRA) is a natural based optimization technique that was proposed by Marrikh-Bayat based on the intellectual behavior of spider plants which proliferate through runners in regular atmospheric conditions. The Runner Root Algorithm (RRA) is one of the advanced optimization technique that deals with penetrating of the best optimal point in searchingregion through utility of root hairs for mineral and water resources. This progression leads to the development of a new model that assist to estimate local as well as global function candidates [6-7]. The motivation of RRA came from meticulous class of plants called strawberry plants that putinto practice the runners for enlargement of root hairs so that it can search and absorb the maximum

resources. The capability of runner to explore the optimal points is based on these essential factsand these important facts are.

(i) The initialization of mother plant population is calculated by

$$X_{mother,k} = round\left[X_{low} + rand(X_{high} - X_{low})\right] \quad (8)$$

Where X_{low}= 1 and X_{high} = maximum distance of length, rand is the random number lie in rangeof [0, 1]

(ii) The ingestion of rich resources leads to fittest daughter plants that produce further supplementary root hairs and runners[8-10]. The daughter plants with fewer resources will get dieultimately. The equation for evaluating the best daughter plant is given by:

$$X_{daughter,k} = \begin{Bmatrix} X_{daughter,best}(i-1), k=1 \\ round\left[X_{mother,k}(i) + D_{run} \times rand\right], k = 2. \ldots N \end{Bmatrix} \quad (9)$$

(iii) The daughter plants fitness value is evaluated as:

$$X^k_{daughter}(i) = \frac{1}{a + f(x^k_{daughter}(i)) - f(x^k_{daughter,best}(i))} \quad (10)$$

Where a is small value of daughter plant.

Figure 2: Basic Process of Runner Root Algorithm (RRA)

3.2 Application of Runner Root Algorithm (RRA) in solving Economic Load DispatchProblem of Micro grid

Step 1: Inserting the input parameters for starting of process

Insert the participation data with input parameters as:

Pgi^{max} and Pgi^{min} are maximum and minimum values of voltages, N is population size , ai, bi, ciare fuel Cost coefficients, B - coefficient matrix, Jr is jumping factor, Pop_{max} is maximum population, PD is Power Demand Factor

Step 2: Data Initialization

The random values of all active power of generators are being initialized along with their minimum and maximum values from the population matrix. There is also consideration of variouslosses and demand factors [11-13].

Step 3: Construction of mother's plant matrix

In this step, the mother plant population matrix is being formed by considering the trial vector having random matrix [14]

Step 4: Fittest parameters selection for creation of daughter plants

This step helps out to find the particular class of fittest candidates from mother plant matrix population that leads to generation of new daughter plant.

Step 5: Construction of daughter plant matrix functions.

In this step, daughter plant matrix is being constructed for identification of fittest function by new parameters that lead to convergence of overall cost factor [15-16].

Step 7: Selection of best daughter plants for computation of the objective function

The formation of daughter plant matrix helps to evaluate the fitness level of candidates that leadsto estimation of fuel cost of each unit with satisfaction of conditions.

Step 8: Fitness and elimination of generated outputs

In this step, fitness of population in plant matrix is calculated and best plant value is chosen which is stored in memory of every iteration. Then, plants with lower rank can be eliminated[17].

Step 9: Selection of new daughter plant as mother plant.

In this step, there is application of application of jumping rate parameter '*Jr*' that acts as catalyst to select the new fittest daughter plant as mother plant within range of values.

Stop 10: Identification of most optimal value of the plant

This is the last step which identifies the best value of plant long with generated output and fuel cost factor. The flowchart for proposed Runner Root Algorithm (RRA*)* which is being used for solving of the economic load dispatch (ELD) problem is shown in figure 3.

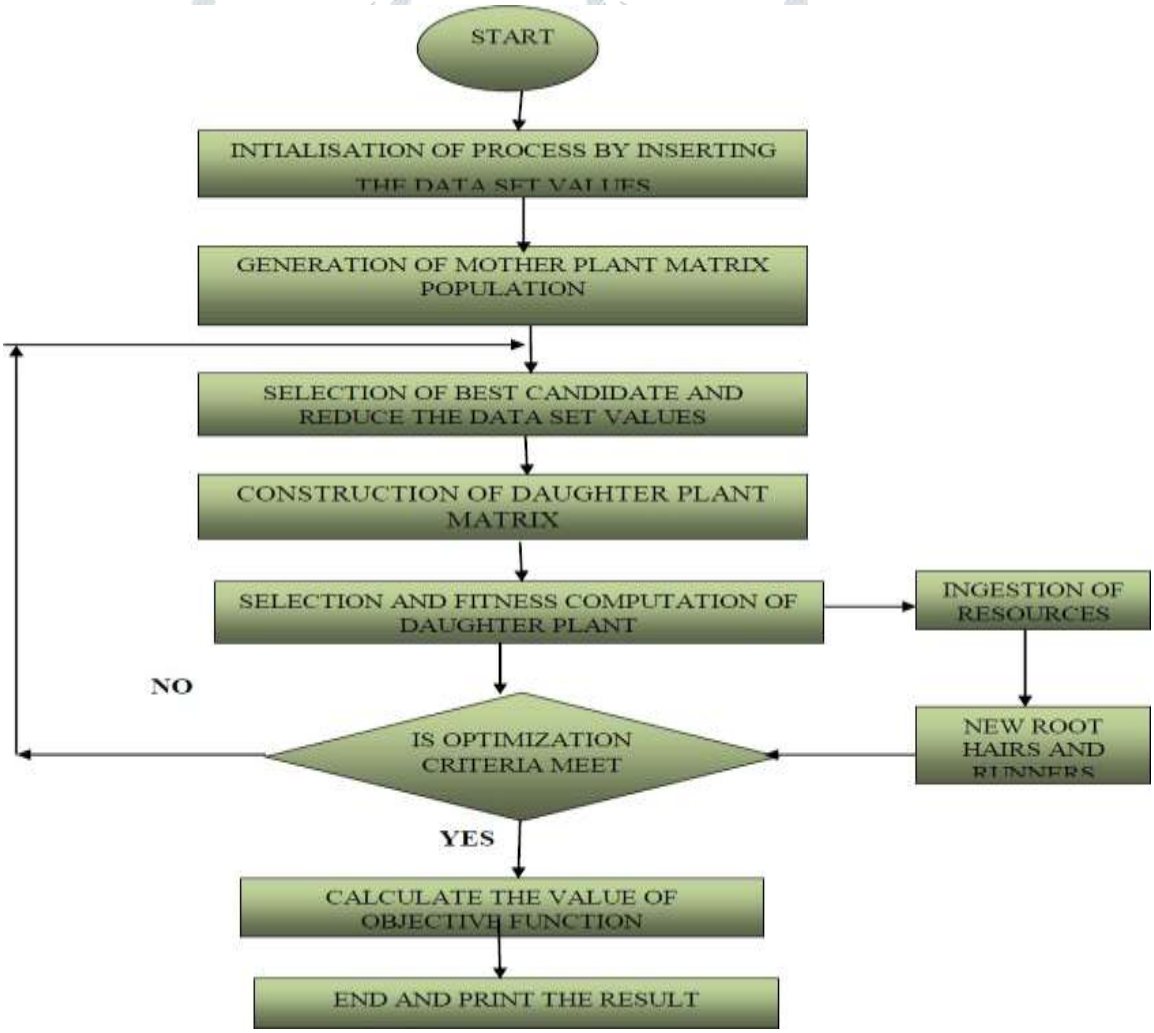

Figure 3: Flowchart of Runner Root Algorithm (RRA)

4. SIMULATION RESULTS

The proposed hybrid algorithm technique used for solving for ELD problem in microgrid is calculated using standard system.

OPTIMIZATION TECHNIQUE	ALL SOURCES	WITHOUT SOLAR	WITHOUT WIND	WITHOUT RES
ACO	19818.4367	10876.2897	16786.5432	17534.6754
IWO	19817.0467	10825.6798	16674.7654	17527.4532
KHA	18815.4321	10799.9876	16666.6894	17514.9087
RRA	16806.6574	10720.9898	16632.6751	17432.5691

TABLE 1: Comparison of Micro grid cost (IN $) for ELD using optimization techniques

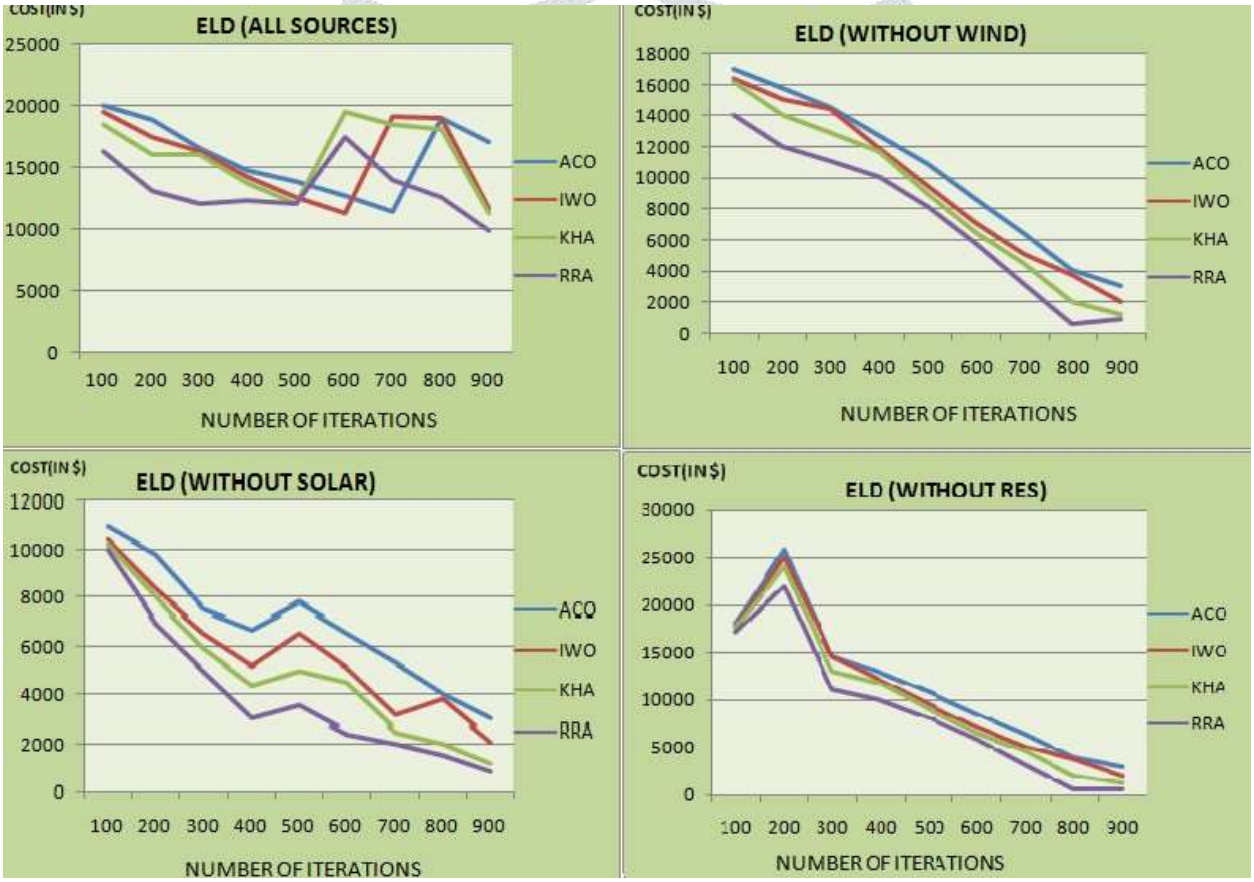

Figure 4: Micro grid cost (IN $) Vs Number of iterations for ELD using Optimization Techniques

5. CONCLUSION

In this paper, the proposed technique called Runner Root Algorithm (RRA) is implemented fruitfully to solve the economic load dispatch (ELD) difficulty of micro grid system. The proposedmethod is successfully weathered and implemented on standard data systems of micro grid construction units. The proposed method is much proficient as compared to other established method stated in the literature for solving of economic optimization problem. This method also shows the superior convergence characteristics for different number of iterations. Therefore, the proposed RRA algorithm is a powerful

tool that has capability to attain the optimal result of ELDproblem of micro grid along with immediate union rate.

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