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Global Neighbourhood Algorithm for Reduction of Actual Power Loss

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Abstract

In this paper, Global Neighbourhood Algorithm (GNA) is utilized for solving the optimal reactive power problem. Projected algorithm is mainly maintaining the balance between global and local exploration. Most outstanding incorporation (g1) is used as a premium measure for the local optimal solution and act as first and foremost set of the supreme recognized solution. In subsequent iteration, 50% of the (m) created solutions will be engendered close to the most outstanding solution of the neighbourhood by using a suitable shift operator. Then the other 50% of the (m) engendered solutions is formed from the entire explore space, and reason for that is to authorize the exploration in search space, since solutions close to the most outstanding solution is chosen then local solution in the region can be found .Proposed Global Neighbourhood Algorithm (GNA) has been tested in standard IEEE 14,300 bus test system and simulation results show the proposed algorithm reduced the real power loss considerably.

Keywords: Optimal Reactive Power; Transmission loss; Global Neighbourhood Algorithm

Introduction

Reactive power problem plays a key role in secure and economic operations of power system. Optimal reactive power problem has been solved by a various type of methods [1-6]. Nevertheless, numerous scientific difficulties are found while solving problem due to an assortment of constraints. Evolutionary techniques [7-15] are applied to solve the reactive power problem [16-19], but the key problem is some algorithms stuck in local optimal solution & failed to balance the Exploration & Exploitation during the search of global solution. In this paper Global Neighbourhood Algorithm (GNA) is utilized for solving the optimal reactive power problem. Projected algorithm is mainly maintaining the balance between global and local exploration. A set of arbitrary solutions are initially engendered from the global exploration space, and then the most excellent solution will give the optimal value. In each iteration there are two sets of engendered solutions; one from the global exploration space and the other set of solutions will be engendered from the neighbourhood of the most excellent solution. Every iteration 25 feasible solutions were engendered from the entire exploration space and the other 25 solutions were engendered from the neighbourhood of the fittest solution. Proposed Global Neighbourhood Algorithm (GNA) has been tested in standard IEEE 14,300 bus test system and simulation results show the proposed algorithm reduced the real power loss considerably.

Problem Formulation

Objective of the problem is to reduce the true power loss:

$$F = P_L = \sum_{k \in Nbr} g_k \left(V_i^2 + V_j^2 - 2V_iV_j \cos\theta_{ij}\right) \quad (1)$$

Voltage deviation given as follows:

$$F = P_L + \omega_v \times Voltage\ Deviation \quad (2)$$

Voltage deviation given by:

$$Voltage\ Deviation = \sum_{i=1}^{Npq} |V_i - 1| \quad (3)$$

a) Constraint (Equality)

$$P_G = P_D + P_L \quad (4)$$

b) Constraints (Inequality)

$$P_{gslack}^{\min} \le P_{gslack} \le P_{gslack}^{\min} \quad (5)$$

$$Q_{gi}^{\min} \le Q_{gi} \le Q_{gi}^{\max}, i \in N_g \quad (6)$$

$$V_i^{\min} \le V_i \le V_i^{\max}, i \in N \quad (7)$$

$$T_i^{\min} \le T_i \le T_i^{\max}, i \in N_T \quad (8)$$

$$Q_c^{\min} \le Q_c \le Q_c^{\max}, i \in N_c \quad (9)$$

Global Neighbourhood Algorithm

Global Neighbourhood Algorithm finds the optimized value amongst the local optimal values by exchanging the exploration and exploitation suitably. Entire search space has been searched by the exploration. In the neighbourhood the search is done by the Exploitation from the most excellent solution of formed solutions. The main function assumed in the proposed methodology

$$\min \ h = f(y_1, y_2, .., y_n) \quad (10)$$

Where, y_1, y_2 ,..., y_n are the dissimilar amalgamation of the solution progression.

Optimal combination has to be identified (y_1, y_2 ,..., y_n) that gives the optimized value for the objective function. In common each of the variables (y_1, y_2 ,..., y_n) can be selected in(n_1, n_2 ,..., n_n) methods correspondingly, then the probable solutions this will acquiesce(n_1,n,..,n_n) solutions. In the proposed Global Neighbourhood Algorithm set of (m) arbitrary solutions are engendered from the set of all probable solution, where ,(y_1, y_2 ,..., y_n) can be selected in(n_1, n_2 ,..., n_n) methods. Engendered solutions will emerge as

$$(y_1^q, y_2^q, ..., y_n^q)$$

where q=1, 2,..,m.

For the solutions fitness value will be calculated and classified as

$$f(g_1) < f(g_2) < f(g_3) < ... < f(g_m) \quad (11)$$

g_1 = (y'_1, y'_2 ,..., y'_n) is the solution progression with most excellent fitness.

The objective distance is calculated by

$$E(T) = e(D_N, D_1) + \sum_{n=1}^{N-1} e(D_n, D_{n+1}) \quad (12)$$

Most outstanding incorporation (g_1) is used as a premium measure for the local optimal solution and act as first and foremost set of the supreme recognized solution. In subsequent iteration, 50% of the (m) created solutions will be engendered close to the most outstanding solution of the neighbourhood by using a suitable shift operator. Then the other 50% of the (m) engendered solutions is formed from the entire explore space, and reason for that is to authorize the exploration in search space, since solutions close to the most outstanding solution is chosen then local solution in the region can be found . Function has to be optimized and the capacity having additional local optima, which will power to get stuck at one of those local optima. Subsequently, the most excellent solution from the above (m) solutions (50%, 50%) is calculated. new value for the most excellent solution is weighed against to most excellent recognized solution and when it finds superior it will be swapped. This procedure is repetitive until a definite end criterion is met. Stop criterion is pre-specified number of iterations. Figure 1 shows the flow chart of the Global Neighbourhood Algorithm [20,21].

a) commence

b) describe the objective function, variables, parameters

c) From the complete explore space engender (m) feasible solutions.

d) Fitness value for all produced (m) solutions is computed by the objective function

e) Best Optimal solution (S) = fittest solution (B)

f) I=0

g) By using a suitable move operator create (50%×m) solutions from the neighbourhood of the fittest solution (most outstanding)

h) From the complete search space engender (50%×m) solutions.

i) Locate the best fittest solution (most outstanding) from above formed (m) solutions.

j) Is most outstanding solutions (superior than) optimal solution (S)?

k) If yes, then S = B

l) If no, I=I+1

m) Is I< t?

n) If yes, then go to step g Or else stop.

Depict objective function

Initialize the values for all parameters (m)

From the exploration space engender (m) feasible solutions

From the objective function calculate the fitness value

Best Optimal solution= the most outstanding solution.

i=1

Do while I < t,++

From the neighbourhood of the most outstanding solution engender 50% × m solutions

From the explore space engender 50% × m solutions

From the (m) created solution find out the most outstanding solution

If most outstanding solution is less (superior) than optimal solution; Best Optimal solution=most outstanding solution

End If

End DO

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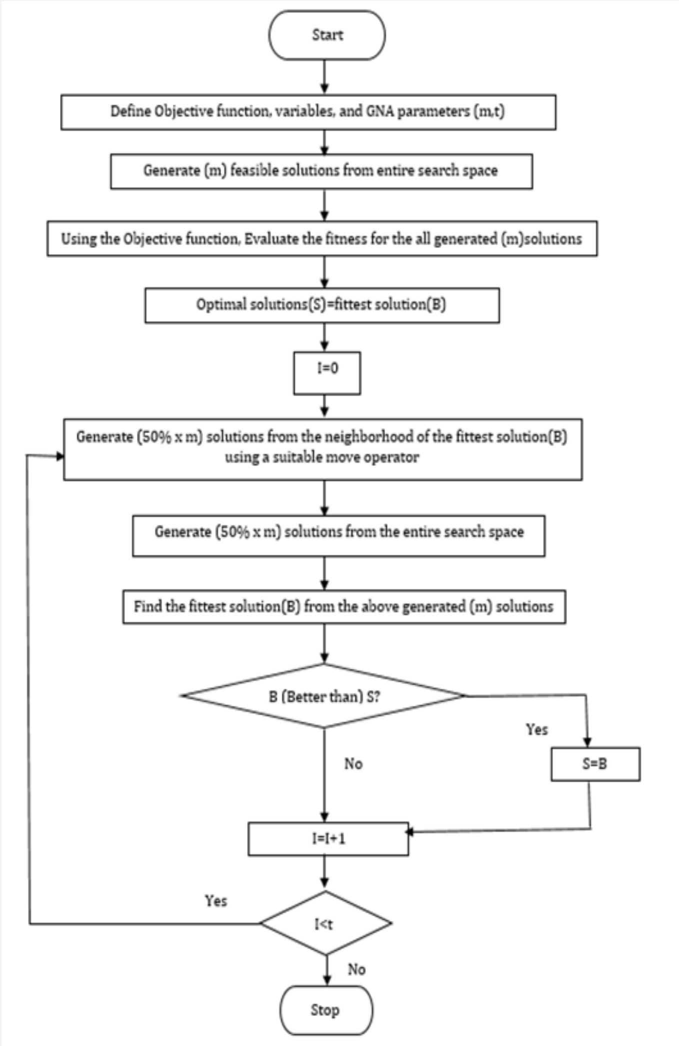

Figure 1: Flow chart for the Global Neighbourhood Algorithm.

Simulation Results

At first in standard IEEE 14 bus system the validity of the proposed Global Neighbourhood Algorithm (GNA) has been tested & comparison results are presented in Table 1. Then IEEE 300 bus system [22] is used as test system to validate the performance of the Global Neighbourhood Algorithm (GNA). Table 2 shows the comparison of real power loss obtained after optimization [23-25].

Table 1: Global Neighbourhood Algorithm (GNA) testing & comparison results.

Control Variables	ABCO [23]	IABCO [23]	GNA
V1	1.06	1.05	1.04
V2	1.03	1.05	1.03
V3	0.98	1.03	1.02
V6	1.05	1.05	1
V8	1	1.04	0.9
Q9	0.139	0.132	0.1
T56	0.979	0.96	0.9
T47	0.95	0.95	0.9
T49	1.014	1.007	1
Ploss (MW)	5.92892	5.50031	4.16728

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Table 2: Comparison of Real Power Loss.

Parameter	Method EGA [25]	Method EEA [25]	Method CSA [24]	GNA
PLOSS (MW)	646.2998	650.6027	635.8942	616.8942

Conclusion

In this work, Global Neighbourhood Algorithm (GNA) is successfully solved the optimal reactive power problem. GNA finds the optimized value amongst the local optimal values by exchanging the exploration and exploitation suitably. Entire search space has been searched by the exploration. In the neighbourhood the search is done by the Exploitation from the most excellent solution of formed solutions. Proposed Global Neighbourhood Algorithm (GNA) has been tested in standard IEEE 14,300 bus test system and simulation results show the proposed algorithm reduced the real power loss considerably.

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