Journal of Basic and Applied Engineering Research
p-ISSN: 2350-0077; e-ISSN: 2350-0255; Volume 3, Issue 7; April-June, 2016, pp. 630-633

http://www.krishisanskriti.org/Publication.html

Real Power Loss Minimization using GSO Algorithm

A.M. Thirunavukkarasu[1] and R. T. Udaya Shanakar[2]

[1]Dept. of Electrical and Electronics Engineering SMK Fomra Institute of Technology Chennai
[2]Power System Engineering SMK Fomra Institute of Technology Chennai
E-mail: [1]erthiruraja@gmail.com, [2]uday91.eee@gmail.com

Abstract—*This paper presents a GSO Algorithm to remit the real power losses and to maintain the voltage profile. Nature inspired meta-heuristics algorithm are among the most powerful algorithm. This problem is a nonlinear combinatorial solution with constraints. The Group search optimization algorithm is inspired by animal behavior, especially animal searching behavior. Newton raphson method of load flow is used in conjunction with GSO algorithm to obtain the optimal values of the control variables. Identify the control variables for this problem are the Generator bus voltages, Transformer Tap settings and the MVAR at the capacitor Banks. The performance of the proposed algorithm has been demonstrated with the IEEE 30 bus system. The GSO algorithm used in the problem is compared to another nature inspired algorithm.*

Keywords*: Optimization of Reactive power, Group Search Optimization Algorithm, Real Power Loss Minimization.*

Nomenclature	
P_{loss}	real power loss
nl	number of lines
n	Number of buses, except swing bus.
G_{ij}	mutual conductance between bus i and j.
B_{ij}	mutual susceptance between bus i and j.
P_i	real power injected into network at bus i.
Q_i	reactive power injected into network at bus i.
V_i	voltage magnitude at bus i.
N_B	total number of buses
Q_{Gi}	Reactive power generation at bus i
N_g	number of generator buses.
Q_{ci}	reactive power generated by i^{th} capacitor bank .
N_c	number of capacitor banks
T_i	tap setting of transformer at branch k.
N_T	number of tap-setting transformer branches.
γ	absorption co-efficient.
R	distance between two flies.
β_0	initial attractiveness at r=0.
r_{ij}	distance between two flies at positions i and j respectively
rand	random number generator

1. INTRODUCTION

Optimization of Reactive power is needed in a system to minimize the real power losses and also to improve the voltage profile. It involves the identification of the optimal values of transformer tap-settings, generator bus voltage magnitudes, the reactive power output of capacitor and the generator bus reactive power. This problem thus includes various equality and inequality constraints and it is a nonlinear combinatorial problem.

Conventional methods used in reactive power optimization are based on linear programming and non-linear programming. Fast Quadratic Programming [1] has also been used for large scale VAR optimization. The major drawback of these methods includes the time consumption and the local minima criteria. It is difficult to handle discrete variables

In order to overcome these drawbacks, evolutionary techniques such as Genetic Algorithm [2] Ant colony search Algorithm [5] PSO Algorithm of its several modifications such as HPLSO & HMAPSO [6, 7] were proposed. Varadarajan and Swarup [8] have reported on Differential Evolution approach for reactive power optimization. Aniruddha Bhattacharya and Pranab Kumar use Biogeography-Based optimization (BBO) [9] for optimal reactive power flow. Harmony search Algorithm (HAS) [11] was presented by Khazali and Kalantar to find the optimized solution. Barun Mandal and Provas Kumar Roy proposed a newly developed teaching learning based optimization (TLBO) [12] algorithm in order to minimize the real power losses in RPD.

Group search optimizer (GSO) is a population based optimization algorithm, inspired by animal foraging behavior. GSO Optimization employs the producer–scrounger (PS) model and the animal scanning mechanism.

The rest of this paper is organized as follows. The mathematical formulation of the optimal reactive power dispatch is presented in section 2. In section 3, GSO algorithm and its implementation in optimization of reactive power is described in detail. The numerical results on IEEE 30 bus system and the comparison with the results provided by other methods such as particle swarm optimization (PSO) techniques is shown in section 4. In section 5 final conclusions are given.

2. MATHEMATICAL PROBLEM FORMULATION

The objective of the reactive power optimization is to minimize the active power loss in the transmission network, which is defined as follows:

$$f = \min \sum_{n=1}^{nl} P_{loss} \quad (1)$$

2.1 Constraints

Equality Constraints. The equality constraints include the real and reactive power constraints which is given as follows,

Real Power Constraint

$$P_i(V,\theta) = \sum_{j=1}^{n} V_i V_j (G_{ij}\cos\theta_{ij} + B_{ij}\sin\theta_{ij}) \quad (2)$$

Reactive Power Constraint

$$Q_i(V,\theta) = \sum_{j=1}^{n} V_i V_j (G_{ij}\sin\theta_{ij} + B_{ij}\cos\theta_{ij}) \quad (3)$$

Inequality Constraints. The inequality constraints include the following,

Bus Voltage Magnitude Constraint

$$V_{i,min} \leq V_i \leq V_{i,max} \;;\; i \epsilon N_B \quad (4)$$

Reactive Power Source Capacity Constraint

$$Q_{Ci,min} \leq Q_{Ci} \leq Q_{Ci,max} \;;\; i \epsilon N_c \quad (5)$$

Transformer Tap Position Constraint

$$T_{k,min} \leq T_k \leq T_{k,max} \;;\; i \epsilon N_T \quad (6)$$

3. GROUP SEARCH OPTIMIZATION ALGORITHM

3.1 Introduction

Group Search Optimization is a newly developed algorithm inspired by animal behavioral ecology. It is a process of obtaining optimum solution in a search space. It consists of three types of members. They are producer, scrounger and ranger.

Group Search Optimization and has been applied successfully to a plethora of optimization problems

3.2 Algorithm & Flow Chart

3.2.1 Producers

At each iteration, the candidate solution (Group member) conferring the best fitness value is chosen as producer. That member evaluates the search area for optimum position. Soon the producer will find a better position with the best fitness value. If that position has a better resource than the current position, then producer moves to that position or it will stay in current position and search for other optimal position. If the producer cannot find a better position, it will retain back to its original position.

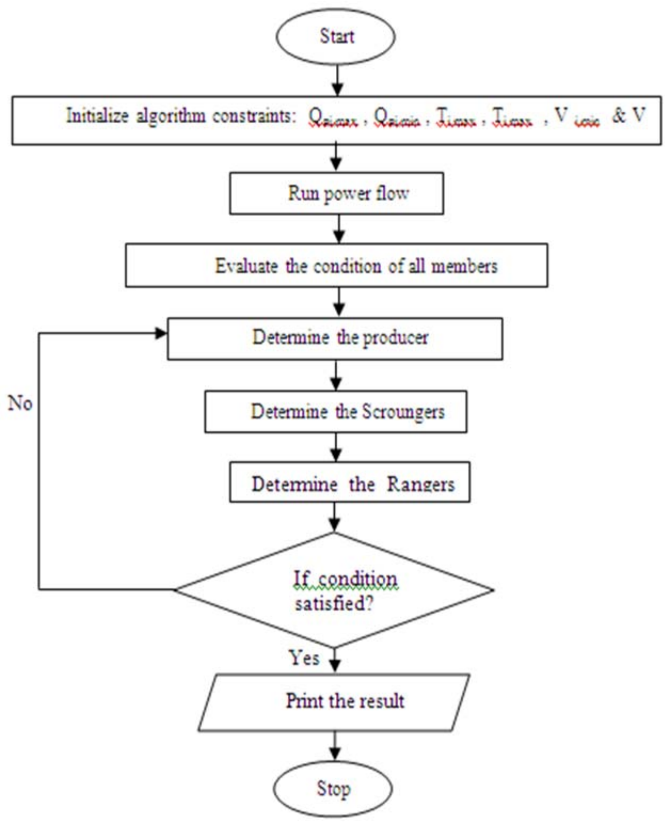

Fig. 31.1: GSO flowchart

3.2.2 Scroungers

The job of the scroungers is keep track of the best fitness values obtained by the producers. In case, the current producer is unable to find better fitness value, it will be replaced by one of those scroungers having better fitness value next to producer. In case, if a scrounger finds better optimum position/area, it will be made as a producer in the following bout

3.2.3 Rangers

The group other than producer and scroungers are the rangers. They are always less in population and do random walk in the search of better resource area.

$$X_i^{k+1} = X_i^k + l_i D_i^k (\varphi^{k+1})$$

When a member escapes from the search space bounds, it will be back to the old position.

4. NUMERICAL EXAMPLE AND RESULTS

The GSO Algorithm has been implemented to IEEE 30-bus system using MATLAB and the results are compared with PSO.

The IEEE 30-bus network consists of 6 generators, 4 transformers, and 41 branches. The voltage and tap setting limits for the IEEE 30-bus is shown in Table 1. The base case real power loss is obtained as 0.17557 p.u. The analysis of the voltage levels shows that the 30th bus is a weak bus.

Table 1: Limits for voltage and tap-setting (in p.u.)

V_G^{max}	V_G^{min}	V_{load}^{max}	V_{load}^{min}	T_k^{max}	T_k^{min}
1.1	0.9	1.05	0.95	1.05	0.95

Table 2. Comparison of simulated results for IEEE 30-bus system (real power loss minimization)

	GA	PSO	GSO
P_{loss} (p.u.)	0.17180	0.15813	0.150084

Table 3: Values of the Control Variables after Optimization

V_1	1.1
V_2	1.0851
V_5	1.0538
V_8	1.1
V_{11}	1.1
V_{13}	1.1
Q_{C10}	2.9094
Q_{C24}	2.1169
T_1	1.0191
T_2	0.9
T_3	0.9415
T_4	0.9254

The real power loss obtained after optimization using GSO algorithm is 15.5084 (MW). The result obtained is compared with that of results obtained from GA and PSO in Table 2. The optimal value of the control variables is provided in Table 3. It is noted that all the control variables are within their specified limits.

The comparison of voltage levels before and after optimization is shown in Fig. 2 and it is seen that the voltage profile of the system has improved after reactive power optimization using GSO Algorithm.

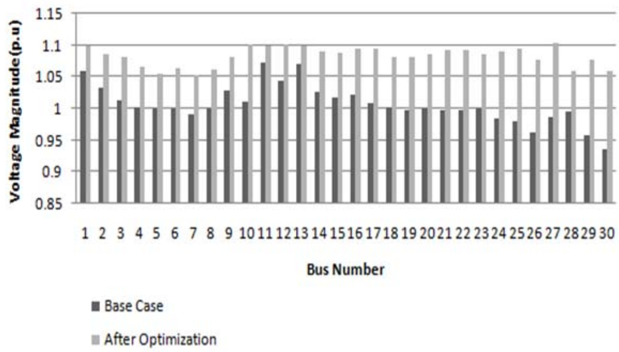

Fig. 6.2: Comparison of Voltage Levels before and After Optimization

5. CONCLUSION

Reactive power optimization for IEEE 30-bus system is reported. GSO algorithm has been successfully implemented to minimize the active power losses in the system satisfying all the power system constraints. The proposed method has been found to be better both in terms of convergence time and reduction in losses when compared to that of GA and PSO.

REFERENCES

[1] M.A.H.El, Sayed, T.M.Abdel-Rahman, M.O.Mansour Fast Quadratic Programming Approach for Large Scale Reactive Power Optimization

[2] Kenji Iha mitsubishi Electric Corp., Kobe, Japan Reactive Power Optimization by Genetic Algorithm IEEE Transaction on Power Systems, Vol.9, No.2, May 1994

[3] B.Venkatesh G.Sadasivam M.Abdullah Khan Fuzzy Logic Based Successive L.P. Method for Reactive Power Optimization Electric Machines and Power Systems, 27:1141-1160, 1999

[4] D.Bhagwan Das, C. Patvardhan Reactive Power dispatch with a hybrid stochastic search technique Electrical Power and Energy Systems 24 (2002) 731-736

[5] K.Lenin, M. R. Mohan Ant Colony Search Algorithm for Optimal reactive Power Optimization Serbian journal of Electrical Engineering vol. 3, No. 1, June 2006, 77-88

[6] A. Shunmugalatha and S. Mary Raja Slochanal. Application of Hybrid Multiagent-based Particle Swarm Optimization to Optimal Reactive Power Dispatch. Electric Power Components and Systems, 36:788-800, 2008.

[7] B. Bhattacharya and S. K. Goswami. Reactive Power Optimization through Evolutionary techniques: A comparative study of the GA, DE and PSO algorithms. Intelligent Automation and Soft Computing, Vol. 13, No. 4, pp. 453-461, 2007

[8] M. Varadarajan, K. S. Swarup. Differential evolution approach for optimal reactive power dispatch. Applied Soft Computing 8 (2008) 1549-1561

[9] Aniruddha Bhattacharya and Pranab Kumar Chattopadhyay. Solution of Optimal Reactive power Flow using Biogeography-Based optimization. International Journal Of Electrical and Electronics Engineering 4:8 2010.

[10] S. Jeyadevi, S. Baskar, C. K. Babulal, M. Willjuice Iruthayarajan. Solving mutiobjective optimal reactive power dispatch using modified NSGA-II. Electrical Power and Energy Systems 33 (2011) 219-228.

[11] A. H. Khazali, M. Kalantar. Optimal reactive power dispatch based on harmony search algorithm. Electrical Power and Energy Systems 33 (2011) 684-692.

[12] Barun Mandal, Provas Kumar Roy. Optimal reactive power dispatch using quasi-oppositional teaching learning based optimization. Electrical Power and Energy Systems 53 (2013) 123-134.

[13] Xin-She Yang. Firefly Algorithms for Multimodal Optimization.

[14] Hadi Saadat (1998)"Power System Analysis", McGraw-Hill Publications

[15] Xin-She Yang. Nature Inspired Meta-heuristic Algorithms. Luniver press.