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Network Reconfiguration Of Distribution System Using Particle Swarm Optimization

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Abstract— This paper present a new simple algorithm for solving the distribution network reconfiguration (DNR) problem. This algorithm is a simple modification to the binary particle swarm optimization (BPSO) called selective particle swarm optimization (SPSO). The search space for proposed algorithm is a set of branches (switches) which are normally closed or normally opened, this search space may be dissimilar for different dimensions. The performance of distribution networks on IEEE -33 bus system has been evaluated using MATLAB programming to test the effectiveness and validity of the proposed algorithm. The obtained results reveal that the proposed methods are promising in distribution system reconfiguration for power loss reduction and voltage profile improvement**.**

Keywords— Distribution Network Reconfiguration, Selective Particle Swarm Optimization, Power Losses Reduction, Capacitor Placement, DG Allocation.

Introduction

The distribution network usually operates in a radial configuration, with tie switches between circuits to provide alternate feeds. Whenever components fail, some of the switches must be operated to restore power to as many customers as possible. As loads vary with time, switch operations may reduce losses in the system and transfer of loads from heavily loaded feeder. All of these are applications for network reconfigurations [1].

Network reconfiguration is a process of changing the status of the network topology through opening or closing tie switches to optimize the network parameters. Under normal conditions the network is reconfigured to reduce the system's losses and/or to balance load in the feeders. Power losses occur in distribution networks due to Joule's effect which can account for as much as 13% of the generated energy [2, 3]. Under condition of permanent failure, the network is reconfigured to restore the service, minimizing the zones without power [4].

In 1975, Merlin and Back proposed a heuristic algorithm to determine the minimum losses configuration. In this algorithm, all network switches are first closed to form a meshed network. The switches are then opened successively to restore radial configuration [5]. In 1986,Stevens et al demonstrated that the ladder based technique is very fast but does not guarantee convergence[6]. In 1988, other heuristic algorithm were proposed by Civanlar et al and Baran et al. This algorithm was based on the branch exchange heuristic method, where a simple formula has been derived to determine how a branch exchange affects the losses [7, 8].

In 1992, Goswami and Basu report a heuristic algorithm that is based on the concept of optimum flow pattern determined via power – flow program. The optimum flow pattern of a single loop formed by closing a normally opened switch is found out, and this flow pattern is established in the radial network by opening a closed switch. This procedure is repeated until the minimum losses reconfiguration is obtained [9]. In 1993, Kim, Ko, and Jung gives idea of artificial neural which is based on the mapping capability to determine network reconfiguration [10]. In 1995, Kennedy and Eberhart developed Particle Swarm Optimization technique. It was developed through simulation of a simplified social, and has been found to be robust in solving continuous nonlinear optimization problem [11]. In 2010, Y.K.Wu suggests reconfiguration allows to relocate locate loads by using an appropriate sequence of switching operations with operating constraints taken into account [12]. In 2012, Khalil and Gorpinich proposed a simple modification to the binary PSO to search in a selected space [13]

Problem Formulation

Reconfiguration is accomplished by choosing, among all probable configurations, the one that incurs the minimum power losses and that satisfies a set of constraints. Generally minimization of network losses is reflected to be objective. Therefore objective function is to reduce the actual power losses of distribution system PL considering the following constraints.

- Branch current constraint

$I_b < I_{bmax}$

Where Ib is the current of branch b, and I_{bmax} is the extreme allowable current of branch b.

- Node voltage constraint

$U_{jmin} < |U_j| < U_{jmax}$

Where U_{jmin} and U_{jmax} are the minimum and maximum allowable rms voltages of node j, respectively.

- Load connectivity.

Each and every bus should be connected via one path to the substation.

- Radial network structure.

This indicates that no loops are allowed in the network.

Proposed Analysis

The basic PSO technique is the real valued PSO, whereby each dimension can take on any real valued number. For d-dimensional search space the position, the velocity and the best previous position for each particle (i-th particle) and best position for all particles are represented by vectors and described as:

$X_i = [x_{i1}, x_{i2}, \dots, x_{id}]$,

$V_i = [v_{i1}, v_{i2}, \dots, v_{id}]$

$PB_i = [pb_{i1}, pb_{i2}, \dots pb_{id}]$ and $GB = [gb_1, gb_2, \dots, gb_d]$ respectively.

At iteration k the velocity and the position for d – dimension of i-th paricle are updated by following equation respectively:

$$v_{id}^{k+1} = wv_{id}^k + c_1r_1(pb_{id}^k - x_{id}^k) + c_2r_2(gb_d^k - x_{id}^k) \quad (1)$$

$$x_{id}^{k+1} = x_{id}^k + v_{id}^{k+1} \quad (2)$$

Where i= 1,2,…n; n is the set of particles in swarm ,(i.e. “ population”)
Described as $pop = [X_1, X_2, \dots X_n]$; w is the inertia weight; c_1 *and* c_2 are the acceleration constants ; r_1 *and* r_2 are the two random values in range [0,1] .
PSO to search in binary spaces by applying a sigmoid transformation to the velocity component to squash the velocities into a range [0, 1] , and force the component values of the locations of particles to be 0’s or 1’s.
The equation (2) for updating positions is then replaced by (4 a , 4 b);

$$sigmoid(v_{id}^{k+1}) = \frac{1}{1 + \exp(-v_{id}^{k+1})} \quad (3)$$

$$x_{id}^{k+1} = \{1, if\ rand < sigmoid(v_{id}^{k+1}) \quad (4\,a)$$

$$x_{id}^{k+1} = \{0, \quad otherwise \quad (4\,b)$$

The solving network reconfiguration problem by SPSO can be divided to three steps:

1 Specifying the number of dimensions
2 Finding the search space for each dimension
3 Using SPSO to select the optimal solution from search spaces.

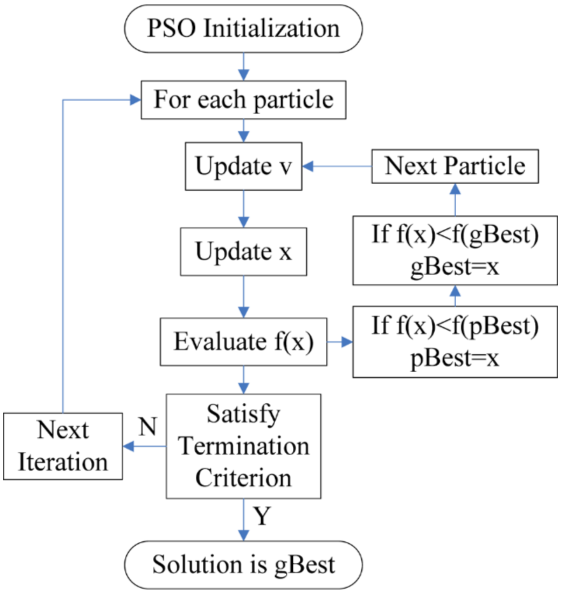

Fig. Flow Chart Particle Swarm Optimization

Results

The proposed approach is implemented using MatLab 2009b at Intel dual core processor CPU 1.6 GHz PC with 8 GB of RAM. The results are explained by finding out all the retrieved relevant information by estimating the different cases with various branch and node that are used in particle swarm optimization. The experimental results of existing approaches based on genetic algorithm and differential and proposed approach are depicted in the form of tables and graphs. Finally, the findings of the all experimented system will be discussed and analyzed.

IEEE 33 Bus System

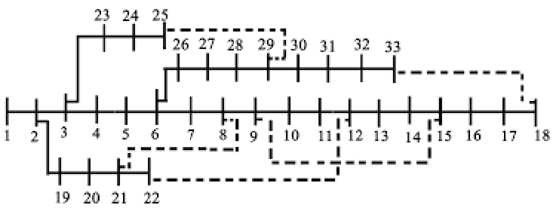

Fig. IEEE 33 Bus system

Graph for network reconfiguration of 33 Bus shows comparison between voltage profile before network reconfiguration and after network reconfiguration.

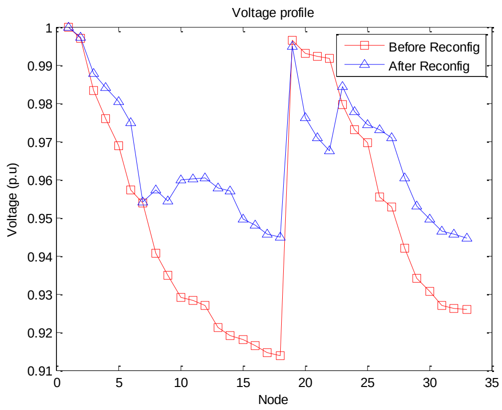

Fig. 4.1 Network Reconfiguration Of 33 Bus

Graph shows voltage pu. By graph we know about voltage pu improvement after network reconfiguration.

After reconfiguration voltage profile improves.

IEEE 33 Bus System With Capacitor Placement

In this case we place capacitor at optimal bus (Q) for getting optimum solution. Capacitor reduce reactive power loss and improves voltage profile [14].

We change in relevant bus as follows:

Table 4.1 Capacitor Placement For 33 Bus

BUS NO	KVAr COMPENSATED
4,8,9,11,15	1200

Graph for network reconfiguration of 33 Bus with capacitor shows comparison between voltage profile before network reconfiguration and after network reconfiguration.

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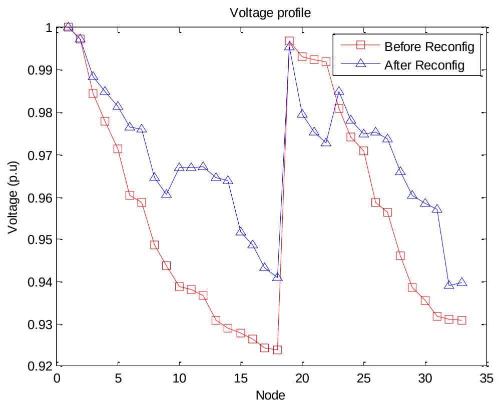

Fig. 4.2 Network Reconfiguration with Capacitor Placement

Graph shows voltage pu. By graph we know about voltage pu improvement after network reconfiguration.

After reconfiguration voltage profile improves.

IEEE 33 Bus With DG Allocation

In this we place DG at optimum (P) bus for optimum solution .DG reduce real power loss [15].

We change in releavant bus as follows:

TABLE 4.2 DG Allocation For 33 Bus

BUS NO	DGSIZES (MW)
18	0.5982
30	0.8432
31	0.1503
32	0.2706

Graph for network reconfiguration of 33 Bus with DG allocation shows comparison between voltage profile before network reconfiguration and after network reconfiguration.

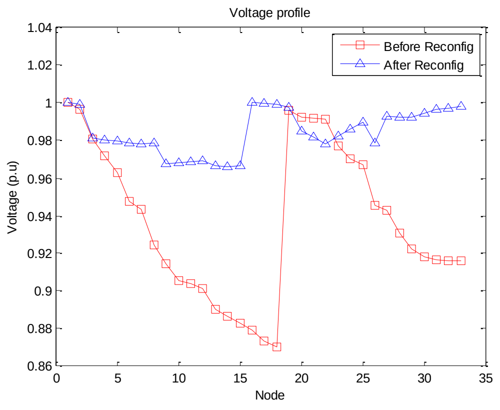

Fig. 4.3 Network Reconfiguration with DG Allocation

IEEE 33 BUS WITH DG ALLOCATION AND CAPACITOR PLACEMENT

In this case we place both DG (P) and Capacitor (Q) at optimum bus for getting optimum solution [16].

DG reduce real power loss and capacitor reduce reactive power loss.

Both improves voltage profile.

We change in releavant bus as follows:

Table 4.3 DG And Capacitor Placement For 33 Bus

BUS NO.	DG SIZES (KW)	CAPACITOR(KVAR)
1		1350
3		750
5	3000	1500
8		2700
9	800	

18	5000	
20		1050
22		900
30		1050

Graph for Network Reconfiguration Of 33 Bus with DG Allocation and Capacitor placement as shows comparison between voltage profile before network reconfiguration and after network reconfiguration.

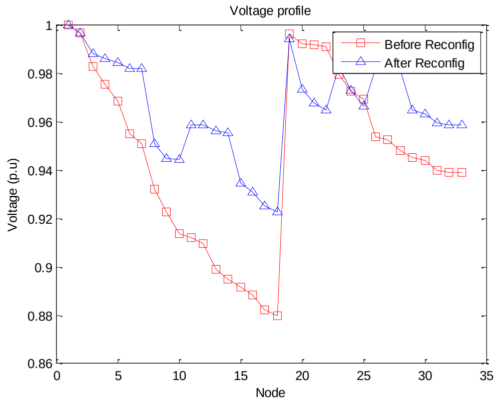

Fig. 4.4 Network Reconfiguration with DG Allocation and Capacitor Placement

Abstract for 33 Bus

	PSO		With Capacitor		With DG		With DG And Capacitor	
	Before Reconfiguration	After Reconfiguration	Before Reconfiguration	After Reconfiguration	Before Reconfiguration	After Reconfiguration	Before Reconfiguration	After Reconfiguration
Tie Switches	33,34,35,36,37	6,9,14,32,37	33,34,35,36,37	7,9,14,31,37	33,34,35,36,37	2,8,14,15,26	33,34,35,36,37	7,10,14,28,36
Loss (KW)	198.14	136.30	168.96	120.49	309.23	83.29	234.77	145.64
Voltage p.u.)	0.9139	0.9446	0.9238	0.9390	0.8705	0.9659	0.8796	0.9228

Conclusion

Simple modification of BPSO to solve the distribution network reconfiguration problem in a simple and proper way. This algorithm is called selective particle swarm optimization, can be used in engineering applications where the search space consists of specific values. The technique is divided to two steps. First step is to simplify the number of dimensions and search space for each dimension. Second step is to apply the SPSO to choose the optimal branch from each dimension to be opened. It has been tested on IEEE 33 bus system. It is also tested for different cases with DG placement, Capacitor placement and with DG and Capacitor placement for IEEE 33 bus system. Result for these systems confirmed the accuracy and efficiency of PSO

. Further work should be done by simplifying matlab coding by that network configuration takes in some few seconds. To optimize the distribution network having DSTATCOM with the help of network reconfiguration technique. Also we can work for make this technique to work on real time monitored data.

REFRENCES

[1]T. Thakur, T .Jaswanti, "*Tabu search based algorithm for multiobjective network reconfiguration problem*," Energy Science and Technology, vol. 1, no.2, pp. 1-10, 2011

[2]G. Kour, and R. K. Sharma, "*Different Techniques of Loss minimization in Distribution system*," International Journal of Enhanced Research in Science Technology & Engineering, vol. 2 issue 2, Feb.-2013.

[3]A. Rouhani, H. R. Mashhadi, and M. A. Ghorbani, "*Reconfiguration of Distribution Network Based on a Genetic Algorithm for Loss Reduction Considering Capacitor Placement*," 8th SASTech 2014 Symposium on Advances in Science & Technology-Commission-IV.

[4]H. Rudnick, I Harnisch ,R. Sanhueza, "Reconfiguration of electric distribution systems, "*Revista Facultad de Ingenieria*", U.T.A (Chile), vol. 4, pp. 41-48, 1997.

[5]A. Merlin, H .Back, "*Search for a minimal-loss operating spanning tree configuration in an urban power distribution systems*," Proc. 5th Power System Computer Conference (PSCC), Cambridge, UK, pp. 1-18, 1975.

[6]Stevens RA, " Performance of conventional power flow routines for real time distribution automation application," Proceedings of the 18th Southeastern Symposium on System Theory, IEEE Computer society,pp.196-200,1986.

[7]S .Civanlar, J.J. Grainger,H. Yin, S. S. H. Lee, "*Distribution feeder reconfiguration for loss reduction*," IEEE Trans. Power Del.,vol. 3 no.3, pp. 1217-1223,July 1988.

[8] M. E. Baran, F. F. Wu, " *Network reconfiguration in distribution systems for loss reduction*," IEEE Trans. Power Del., vol.4, no. 2, pp. 1401-1407,April 1989.

[9] S .K. Goswami , S. K. Basu, " *A new algorithm for the reconfiguration of distribution feeders for loss minimization*," IEEE Trans. Power Del., vol. 7, no, 3, pp. 1484-1491, July 1992.

[10]H. Kim, Y. Ko, K.H. Jung, " Artificial neural network base feeder reconfiguration for loss reduction in distribution systems," IEEE Trans. Power Delivery, vol.8, no.3, pp.1356-1366, July 1993.

[11]J. Kenedy, R. Eberhart , "Particle swarm optimization," Proc. IEEE Int.Conf. on neural networks, vol.4, pp. 1942-1948,November 1995.

[12]Y. K. Wu, et al, " Study of Reconfiguration for the distribution system with distributed generators," IEEE Power Delivery, vol.25, no.3, pp. 1678-1685, July 2010.

[13]Tamer M. Khalil, Alexandar V. Gorpinich, "Selective particle swarm optimization," IJMSE, vol.3, pp.1-4, April 2012.

[14]Ramnarayana Vemana, Dr.M. Sridhar, " *A particle swarm optimization to optimal shunt-capacitor placement in radial distribution systems*," IJAREEIE. Vol. 2,no.10,pp. 4487-4895, October 2013.

[15]M. Padma Lalitha, V. C. Veera Reddy, V. Usha, N. Sivarami Reddy , " *Applicationof fuzzy and pso for DG placement for minimum loss in radial distribution system*," APRN Journal of Engineering and Applied Sciences. vol.5, no. 4, pp. 30-37, April 2010.

[16] M Heydari, S. M. Hosseini, S. A. Gholamian," *Optimal placement and sizing of capacitor and distributed generation with harmonic and resonance considerations using discrete particle swarm optimization*," IJISA. vol. 5, no 7,pp.42-49, June 2013.