

Evaluation of Load Uncertainty in the Reconfiguration using Hybrid Algorithms

I. Moradi

Islamic Azad University,
Bushehr Science and Research Branch, Bushehr, Iran

R. Mohammadi

Abbaspour College of Technology,
Shahid Beheshti University, Tehran, Iran

Abstract – One of the methods of the electrical energy saving is system reconfiguration. In this way the Breakers in distribution systems are opened and closed, so system topology that changes voltage profile and delivered power in feeders and lines would also change, in this method we can have a are reduction in number of lines and a suitable voltage profile.

This closure and opening of the breakers are so happened to have a radius system configuration – In this article we offer a new method to reach a solution to the system reconfiguration. Production scenario method for modeling loaduncertainty is also offered and used. And finally this case, in presence of distributed productions, is analyzed and solved. For on optimum result a hybrid algorithm including PSO and SEL is utilized. For showing the best results in the above methods the case is offered in standard IEEE distribution system, its conclusions are available too.

Keywords – Reconfiguration, Uncertainty, Hybrid Algorithm, Optimization, Power Loss.

I. INTRODUCTION

Configuration of distribution system is radius and is used so, however, electrical losses one lower when there is a loop but in this state we would have a complicated network protection system and an increase in the level of short circuit voltage that is, the radius configuration is preferable. By making progress in sending and processing the data and making use of that in distribution systems has made it possible to have reconfiguration, it means that having load information of the system in each time help us to have reconfiguration in the system and leads to a suitable operation of the distribution system.

There have been a lot of studies on system reconfiguration. In 1975 Merlin and Back offered reconfiguration [1], their method is called Brance and Bound and DC load sharing was used. In 1989 Shirmohamadi expanded this method and made use of feeder passing current item besides using the weak loop form of the system that leads to a lower network losses [2].

In 1988 Civanlar suggested the way that have replacement of lines that is closing of a breaker would lead to the opening of the other in order to have a radius system configuration and continued until to reach the lowest level of system losses[3]. In 2005 Gomes offered the way that all of the breakers were closed at first to have a loop and then were opened so to reach a radius configuration and the lowest losses [4].

In [5] the authors presented the nervous system to have a reduction of losses in reconfiguration. Also in [6] the writers have applied PSO and ACO combined algorithm to solve distribution feeder reconfiguration.

In this article a suitable trend to get rid of the reconfiguration is offered and electrical losses, voltage disturbance and the number ofswitching also used as a goal function. All of the details of load sharing, line passing current and a suitable voltage profile are applied and a combined algorithm including PSO and SFL Are used for a goal function optimization. Finally this case is solved in presence of distributed productions and the results are compared.

II. FORMULATION

In this chapter goal functions, their way of formulation and also practical limitation of this case is presented. Load uncertainty modeling that is showed simulation is also considered in the following vector Control.

Before defining the goal functions and the details, vector control should be defined. Vector control includes the two parts, the switches condition part and using distributed production part. Vector control is showed as follow:

$$X = [Tie_1 \quad Tie_2 \quad \dots \quad Tie_{NT} \quad P_{G1} \quad P_{G2} \quad \dots \quad P_{GN} \quad PF_1 \quad PF_2 \quad \dots \quad PF_N] \quad (1)$$

Tie_k: the condition of the kth switch.

P_{gk}: output kth active power.

PF_k: K th distributed production power factor

Goal functions

A. Minimizing power loss

One of the most important gals that is considered in distribution network operation is minimizing active power loss. Therefore the first goal function is offered as below:

$$P_{Loss} = \sum_{k=1}^{N_{brch}} \left(R_k \times |I_k|^2 \right) \quad (2)$$

That: N_{br} is the number of branches

I_k is passing current of the kth branch

R_k is ohmic resistance of the kth branch

B. Minimizing the Switchings

One of the most important issues in operating and protection of distribution network is minimizing the number of switchings. This causes increasing of the life of the switches. This goal function is presented as below:

$$SW = \sum_{i=1}^{N_s} |S_i - S_{oi}| \quad (3)$$

That S_{oi} and S_i are primary state and new state of the ith switch respectively (0 means closed, 1 means open) and N_s is total number of switches.

Minimizing voltage deviation of the rated value minimization of the voltage deviations of the rated value and compromising of the voltage profile lead to a safe operation the network. This goal function is defined as below:

$$V_{\text{Deviation}} = \sum_{i=1}^{N_{\text{Bus}}} (|V_n - V_i|) V_n \quad (4)$$

That V_n and V_i are rated voltage value and real value of the i th bus voltage respectively.

Details

The case details are listed as below:

Limitation of bus voltage

The bus voltage should change in a certain rate, usually 5% voltage deviation of the rated value is normal.

$$V_{\text{min}} < V_i < V_{\text{max}} \quad (5)$$

• Line passing power limitation

Line passing power value shouldn't be out of its maximum value.

$$|P_{ij}^{\text{line}}| < P_{ij,\text{max}}^{\text{line}} \quad (6)$$

System configuration

System configuration form should be radius.

Production power limitation is distributed productions production power in distributed productions is less than maximum production capacity.

$$S_{DG} < S_{DG}^{\text{max}} \quad (7)$$

III. OPTIMIZATION AND UNCERTAINTY

A. Optimization

In this paper, a new hybrid algorithm (combination of PSO & SFL algorithms) for optimization of goal functions is used. The details and concepts of SFL & PSO algorithms are presented in [1] and [8] respectively. The main advantages of SFL algorithm in comparison to the mathematical algorithms and other complemented optimization methods are: total proper search capability in all of the calculating space and dividing that to some subspace and finding an optimized answer plus simple concepts and less calculating operations [7].

In other hand, PSO algorithm [8] by considering less speed of the crowd movement in first repetitions, causes losing the optimum local responses. Also, simplicity of execution and high speed of this algorithm caused to be used widely in last articles.

Flowchart of the offered algorithm for solving the case is shown in below.

B. Uncertainty

The other way modeling power systems uncertainty is production scenario Method. In this way probability Density Function parameter is obtained from the previous information and then is discretized. In fig 1 is shown that 7 different intervals to the average null center is considered that the difference between the different parameter predicting fault levels is equipment to the predicting fault parameter disturbance[9], [10], [11].

It is usual that any increase in load predicting fault probability level leads to have a big space in rolling wheel.

Fig.2. Shows how is rolling wheel working. After formation of the rolling wheel a zero to one range random number is produced that locates in one of the parts in rolling wheel which shows different parameter prediction

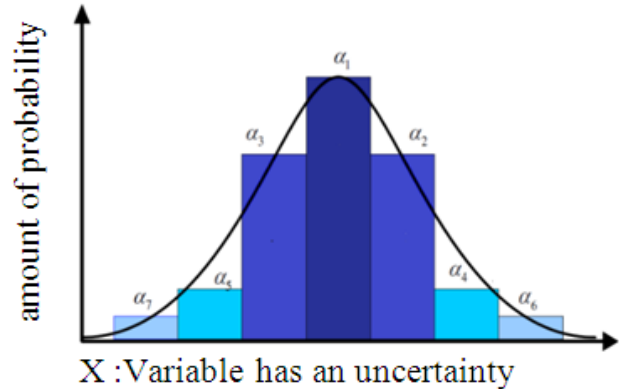


Fig.1. Probability density function sample and the way of its discretization.

level. This probability level is used for this scenario. After this, for making a new scenario, rolling wheel trend is used to model random operation of uncertain parameter. By gathering of all of the uncertain sources faults the first scenario would be produced and multiplication of uncertainty parameters probabilities their probabilities would be obtained that leads to a solution to the case.

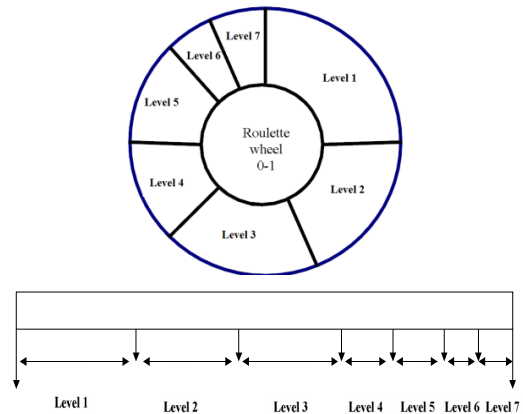


Fig.2. The way of making use of the rolling wheel for the generation of a random value for a scenario.

IV. SIMULATIONS

The below figure (fig 3) in a standard IEEE system that includes 11 feeders, 84 buses and 13 loops. Primary system losses values 531.99 kW and named system voltage 11.4 kv. More information is offered in [12]. The loads 17, 18, 19, 20, 21, 22, 23, 24 and 25 are house loads and have uncertainty. Distributed productions type in this paper is a 500 kW micro turbine. This distributed production is installed on the buses 13, 20, 35, 75, 80.

But using of this algorithm reaches the losses value to 463.286 kW. In other words losses reduction is 12.9 percent. In this state the switches 7, 14, 34, 39, 42, 55, 62, 72, 83, 86, 88, 90, 93 are opened. In continue the case would be studied in away to reach a multipurpose state. The multipurpose state is called Pareto optimum [13]. Fig 4 below shows the achieved surface by the mentioned algorithm. The points, in points ray are not conquered points. These points have no preference toward each other and they would be calculated in an optimum

way. Choosing any point in the system is totally desired and is done by the system operator.

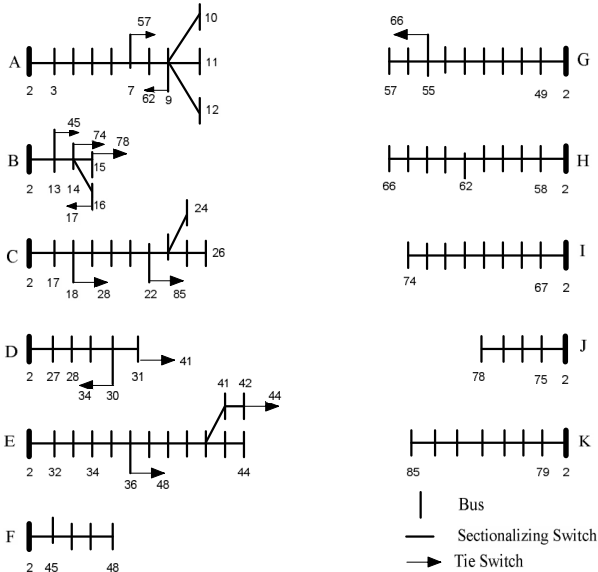


Fig.3. Schematic diagram of an 84 bus IEEE standard distribution system in [2], [3] the losses value by using the mentioned algorithm and neglation of distributed productions in system is 469.88 kW.

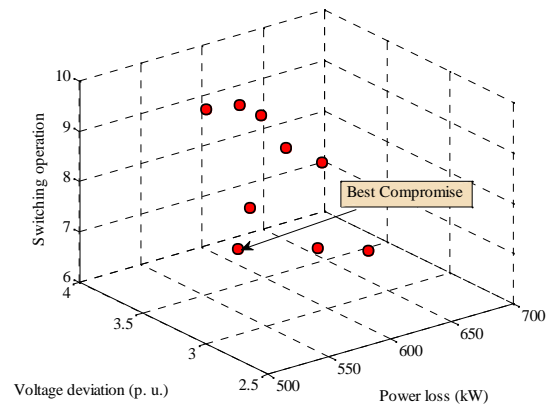


Fig.4. Double goal curve by considering probability relations.

It is clear that after saving the case there is a development in voltage profile.

In table 1 is seen that the best compromise results of the ray method, is a rather logic compromise among the other results. In the other word the values of the goal function is optimized simultaneously. When there would be paradox in goal functions this method is used. Voltage profile department is also used. The fig 5 shows primary voltage profile curve (red profile) and voltage profile after multipurpose reconfiguration by ray method (blue profile).

Table 1: showing vector control and values of goal function in different methods.

method	Open switch	Power active of distributed generation	Power Factor of Distributed Generation	Losses	Voltage Deviation	Number of switching
P best Pareto optimum	8, 15, 35, 40, 43, 56, 63, 84, 87, 88, 89, 91, 93	22.47, 265.97, 250.59, 77.82, 389.01	0.26, -.334, 0.222, -.442, 0.0388	511.84	3.0845	8
Minimum losses	8, 14, 33, 35, 36, 44, 56, 62, 82, 88, 90, 91, 96	343.48, 349.1, 92.93, 62.405, 126.638	.728, 0.736, -.2786, 0.269, 0.009	468.82	4.7731	9
Minimum voltage Deviation	14, 16, 17, 28, 30, 56, 63, 71, 84, 86, 87, 95, 96	62.65, 460.81, 39.13, 474.36, 232.098	0.7436, 0.226, -0.113, -0.696, 0.35328	509.13	2.6908	10
Minimum switching	85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97	500, 500, 500, 500, 500	0.8, 0.8, 0.8, 0.8, 0.8	532.003	3.0139	0

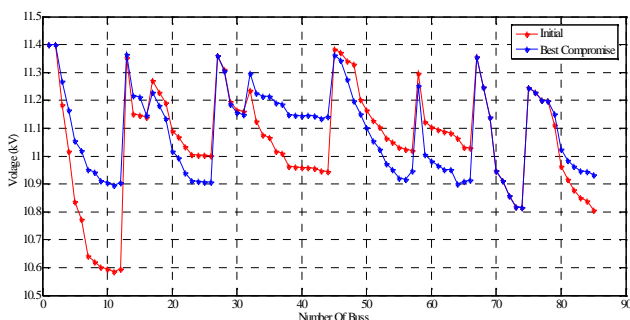


Fig.5. voltage profile curve before (red profile) and after reconfiguration.

V. CONCLUSION

In this paper three goal functions (losses, voltage disturbances and switchings) are simultaneously used that optimized ray method in distribution system reconfiguration is also considered. Scenario Production Method for loads uncertainty modeling is used too. Finally PSO and SFL combined algorithms are used for better

optimization. As shown in simulation results suggested algorithm operation is better than previous algorithms. Also by using ray method can achieve compromise answers between the goal functions that are in paradox. Finally by considering parameters uncertainty can reach a real answer.

REFERENCES

- [1] Merlin A., H. Back, Search for a minimal-loss operating spanning tree configuration in an urban power distribution system, in Proc. 5th Power System Computation Conf., Cambridge, U.K., 1-18. (1975).
- [2] D Shirmohammadi., H. W. Hong, Reconfiguration of electric distribution networks for resistive line loss reduction, IEEE Trans. Power Syst.,4(1): 1492-1498, (1989).
- [3] Civanlar S., J. J. Grainger, H. Yin, and S. S.H. Lee, Distribution feeder reconfiguration for loss reduction, IEEE Trans. Power Del.,3(3): 1217-1223,(1988).
- [4] Gomes V., s.Cameiro, A new reconfiguration algorithm for large distribution systems, IEEE Trans.Power Del. System.,20(3): 1373-1378, (2005).
- [5] H. Kim, Y. Ko, 'Artificial Neural Network Based Feeder Reconfiguration For Loss Reduction In Distribution Systems,' IEEE Trans. On Power Delivery 1993 8(3): 1356-1367.

- [6] Niknam T. 'An efficient hybrid evolutionary based on PSO and ACO algorithms for distribution feeder reconfiguration,' European Transaction on Electrical Power 2010 20(5):575-590.
- [7] M. M. Eusuff and K. E. Lansey, "Optimization of water distribution network design using the shuffled frog leaping algorithm," Journal of Water Resources Planning and Management, vol. 129, p. 210, 2003.
- [8] J. Kennedy and R. Eberhart, "Particle swarm optimization," in IEEE international conference on neural networks, Piscataway, NJ, 1995, pp. 1942-1948 vol. 4.
- [9] N. Amjady, J. Aghaei, and H. A. Shayanfar, "Stochastic multiobjective market clearing of joint energy and reserves auctions ensuring power system security," IEEE Transactions on Power Systems, vol. 24, no. 4, pp. 1841-1854, 2009.
- [10] F. Bouffard, and F. D. Galiana, "Stochastic security for operations planning with significant wind power generation." IEEE Conference, pp. 1-11, 2008.
- [11] J. Dupaová, N. Gröwe-Kuska, and W. Römisch, "Scenario reduction in stochastic programming," Mathematical programming, vol. 95, no. 3, pp. 493-511, 2003.
- [12] Ahuja A, Das S, Pahwa A, 'An AIS-ACO hybrid approach for multi-objective distribution system reconfiguration,' IEEE Transactions on Power Systems 2007 22(3):1101-1111.
- [13] J. Chiou, F. S. Wang, 'A Hybrid Method Of Differential Evolution With Application To Optimal Control Problems Of A Bioprocess System,' In Proc. IEEE Evol. Comput. Conference 1998: 627-632.
- [14] J. Aghaei, N. Amjady, and H. Shayanfar, "Multi-objective electricity market clearing considering dynamic security by lexicographic optimization and augmented epsilon constraint method," Applied Soft Computing, 2011.

AUTHOR'S PROFILE



Iman Moradi

was born in 1985 in Kazerun, Iran. He received the B.S. degree in electrical engineering from Azad Islamic University, Kazerun in 2009 and M.S degree in electrical engineering from Science and Research Branch, Azad Islamic University, Bushehr, Iran in 2013. From 2009, he is a Lecturer at Azad Islamic

University, Kazerun. His research interests include power system studies and intelligent methods.



Reza Mohammadi

was born in 1981 in Tabriz, Iran. He received the B.S. degree in electrical engineering from Iran University of Science and Technology (IUST) in 2004 and M.S. and Ph.D degree in electrical engineering from Amirkabir University of Technology (AUT) in 2007 and 2011 respectively. Currently, he is an assistant

professor of Abbaspour College of Technology, Shahid Beheshti University, Iran, working in the area of the power system protection. His field of interest includes power system protection, power system transient analysis, distributed generation and intelligent methods.