

PSO Based Multi-objective Optimization for Reconfiguration of Radial Distribution Network

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Abstract

This paper proposed particle swarm optimization (PSO) algorithm based multi-objective optimization for reconfiguration of radial distribution network with the presence of distributed energy resources (DER). The benefits of DER integration in distribution system are reducing power losses, improving voltage profiles and load factors, eliminating system upgrades, and reducing environmental impacts. However, the presence of DER could also cause technical problems in voltage quality and system protection. Reconfiguration of distribution network is aimed to minimize power loss and to improve voltage quality in order to enhance the distribution system performance. In this study, reconfiguration method is based on an improved PSO. The method has been tested in an IEEE model of 33-bus radial distribution network test system. The simulation results show the importance of reconfiguring the network for enhancing the distribution system performance in the presence of DER.

Keywords: distribution network, reconfiguration, efficiency, particle swarm optimization, distributed energy resources.

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References

- [1] Merlin A., and Back, H., 1975, "Search for a minimal-loss operating spanning tree configuration in an urban power distribution system", Proc. 5th PSCC Conference, Cambridge, U.K. pp.1–18.
- [2] Mendoza, J., Lopez, R., Morales, D., and Moraga, R., 2006, "Minimal loss reconfiguration using genetic algorithms with restricted population and addressed operators", IEEE Trans. on PS, vol.21(2), pp. 948–954.
- [3] Falaghi, H., Haghifam, M.R., and Singh, C., 2009, "Ant Colony Optimization-Based Method for Placement of Sectionalizing Switches in Distribution Networks Using a Fuzzy Multiobjective Approach", IEEE Trans on Power Delivery, Vol. 24, No. 1, pp. 268-276.
- [4] Syahputra, R., Robandi, I., Ashari, M. (2015). Performance Improvement of Radial Distribution Network with Distributed Generation Integration Using Extended Particle Swarm Optimization Algorithm. International Review of Electrical Engineering (IREE), 10(2). pp. 293-304.
- [5] Syahputra, R., Robandi, I., Ashari, M. (2015). Reconfiguration of Distribution Network with DER Integration Using PSO Algorithm. TELKOMNIKA, 13(3). pp. 759-766.
- [6] Syahputra, R., Robandi, I., Ashari, M. (2015). PSO Based Multi-objective Optimization for Reconfiguration of Radial Distribution Network. International Journal of Applied Engineering Research (IJAER), 10(6), pp. 14573-14586.
- [7] Syahputra, R. (2015). Simulasi Pengendalian Temperatur Pada Heat Exchanger Menggunakan Teknik Neuro-Fuzzy Adaptif. Jurnal Teknologi, 8(2), pp. 161-168.
- [8] Syahputra, R. (2015). Characteristic Test of Current Transformer Based EMTP Software. Jurnal Teknik Elektro, 1(1), pp. 11-15.
- [9] Syahputra, R., (2012), "Distributed Generation: State of the Arts dalam Penyediaan Energi Listrik", LP3M UMY, Yogyakarta, 2012.
- [10] Jamal, A., Suropto, S., Syahputra, R. (2015). Multi-Band Power System Stabilizer Model for Power Flow Optimization in Order to Improve Power System Stability. Journal of Theoretical and Applied Information Technology, 80(1), pp. 116-123.
- [11] Syahputra, R., Robandi, I., Ashari, M. (2014). Optimization of Distribution Network Configuration with Integration of Distributed Energy Resources Using Extended Fuzzy Multi-objective Method. International Review of Electrical Engineering (IREE), 9(3), pp. 629-639.
- [12] Syahputra, R., Robandi, I., Ashari, M. (2014). Performance Analysis of Wind Turbine as a Distributed Generation Unit in Distribution System. International Journal of Computer Science & Information Technology (IJCSIT), Vol. 6, No. 3, pp. 39-56.
- [13] Syahputra, R., Robandi, I., Ashari, M., (2014), "Distribution Network Efficiency Improvement Based on Fuzzy Multi-objective Method". IPTEK Journal of Proceedings Series. 2014; 1(1): pp. 224-229.
- [14] Jamal, A., Syahputra, R. (2014). Power Flow Control of Power Systems Using UPFC Based on Adaptive Neuro Fuzzy. IPTEK Journal of Proceedings Series. 2014; 1(1): pp. 218-223.
- [15] Jamal, A., Syahputra, R. (2011), "Model Power System Stabilizer Berbasis Neuro-Fuzzy Adaptif", Semesta Teknika, Vol. 14, No. 2, 2011, pp. 139-149.

- [16] Syahputra, R., (2013), "A Neuro-Fuzzy Approach For the Fault Location Estimation of Unsynchronized Two-Terminal Transmission Lines", *International Journal of Computer Science & Information Technology (IJCSIT)*, Vol. 5, No. 1, pp. 23-37.
- [17] Jamal, A., Syahputra, R. (2013). UPFC Based on Adaptive Neuro-Fuzzy for Power Flow Control of Multimachine Power Systems. *International Journal of Engineering Science Invention (IJESI)*, 2(10), pp. 05-14.
- [18] Syahputra, R., (2012), "Fuzzy Multi-Objective Approach for the Improvement of Distribution Network Efficiency by Considering DG", *International Journal of Computer Science & Information Technology (IJCSIT)*, Vol. 4, No. 2, pp. 57-68.
- [19] Jamal, A., Syahputra, R. (2012), "Adaptive Neuro-Fuzzy Approach for the Power System Stabilizer Model in Multi-machine Power System", *International Journal of Electrical & Computer Sciences (IJECS)*, Vol. 12, No. 2, 2012.
- [20] Utomo, A.T., Syahputra, R., Iswanto, (2011), "Implementasi Mikrokontroler Sebagai Pengukur Suhu Delapan Ruangan", *Jurnal Teknologi*, 4(2).
- [21] Syahputra, R., (2010), "Aplikasi Deteksi Tepi Citra Termografi untuk Pendeteksian Keretakan Permukaan Material", *Forum Teknik*, Vol. 33, 2010.
- [22] Syahputra, R., Soesanti, I. (2015). "Control of Synchronous Generator in Wind Power Systems Using Neuro-Fuzzy Approach", *Proceeding of International Conference on Vocational Education and Electrical Engineering (ICVEE) 2015*, UNESA Surabaya, pp. 187-193.
- [23] Syahputra, R., Robandi, I., Ashari, M. (2014). "Optimal Distribution Network Reconfiguration with Penetration of Distributed Energy Resources", *Proceeding of 2014 1st International Conference on Information Technology, Computer, and Electrical Engineering (ICITACEE) 2014*, UNDIP Semarang, pp. 388 - 393.
- [24] Soediby, Ashari, M., Syahputra, R. (2014), Power loss reduction strategy of distribution network with distributed generator integration. *1st International Conference on Information Technology, Computer, and Electrical Engineering (ICITACEE) 2014*, UNDIP Semarang, pp. 404 – 408.
- [25] Syahputra, R., Robandi, I., Ashari, M., (2013), "Distribution Network Efficiency Improvement Based on Fuzzy Multi-objective Method". *International Seminar on Applied Technology, Science and Arts (APTECS)*. 2013; pp. 224-229.
- [26] Riyadi, S., Azra, R.A., Syahputra, R., Hariadi, T.K., (2014), "Deteksi Retak Permukaan Jalan Raya Berbasis Pengolahan Citra dengan Menggunakan Kombinasi Teknik Thresholding, Median Filter dan Morphological Closing", *Simposium Nasional Teknologi Terapan (SNTT)2 2014*, UMS Surakarta, pp. 46-53.
- [27] Syahputra, R., Robandi, I., Ashari, M., (2012), "Reconfiguration of Distribution Network with DG Using Fuzzy Multi-objective Method", *International Conference on Innovation, Management and Technology Research (ICIMTR)*, May 21-22, 2012, Melacca, Malaysia.
- [28] Jamal, A., Syahputra, R., (2011), "Design of Power System Stabilizer Based on Adaptive Neuro-Fuzzy Method". *International Seminar on Applied Technology, Science and Arts (APTECS)*. 2011; pp. 14-21.
- [29] Syahputra, R. (2010). Fault Distance Estimation of Two-Terminal Transmission Lines. *Proceedings of International Seminar on Applied Technology, Science, and Arts (2nd APTECS)*, Surabaya, 21-22 Dec. 2010, pp. 419-423.

- [30] Syahputra, R., (2015), “Teknologi dan Aplikasi Elektromagnetik”, LP3M UMY, Yogyakarta, 2016.
- [31] Syahputra, R., (2014), “Estimasi Lokasi Gangguan Hubung Singkat pada Saluran Transmisi Tenaga Listrik”, *Jurnal Ilmiah Semesta Teknik* Vol. 17, No. 2, pp. 106-115, Nov 2014.
- [32] Syahputra, R., Robandi, I., Ashari, M., (2011), “Modeling and Simulation of Wind Energy Conversion System in Distributed Generation Units”. *International Seminar on Applied Technology, Science and Arts (APTECS)*. 2011; pp. 290-296.
- [33] Syahputra, R., Robandi, I., Ashari, M., (2011), “Control of Doubly-Fed Induction Generator in Distributed Generation Units Using Adaptive Neuro-Fuzzy Approach”. *International Seminar on Applied Technology, Science and Arts (APTECS)*. 2011; pp. 493-501.
- [34] Syahputra, R., (2015), “Teknologi dan Aplikasi Elektromagnetik”, LP3M UMY, Yogyakarta, 2016.
- [35] Niknam, T., Meymand, H.Z., and Mojarrad, H.D., 2011, “A practical multi-objective PSO algorithm for optimal operation management of distribution network”, *Renewable Energy (Elsevier)*, 36, pp.1529-1544.
- [36] Ashari, M., Anam, S., and Surojo, 2011, “A Wide Range Fuzzy Based Maximum Power Point Tracker for Improving the Efficiency and Sizing of PV Systems”, *Jurnal of Electrical Engineering (JEE)*, 11(2).
- [37] Ashari, M., and Nayar, C.V., 2000, “A Grid-interactive Photovoltaic Uninterruptible Power Supply System Using Battery Storage and a Backup Diesel Generator”, *IEEE Transactions on Energy Conversion*, 15(3).
- [38] Kennedy, J., and Eberhart, R.C., 1995, “Particle swarm optimization,” in *Proc IEEE Int Conf Neural Networks*, vol. 4, pp. 1942–1948.