Reconfiguration of Power Distribution Systems Considering Reliabilty and Losses using BAT Algoritham

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***Abstract*—Distribution systems are most usually utilized to provide electricity to the consumers. But this process included several drawbacks. One of the most significant limitations is a large amount of power losses during the generation of electricity. A number of researches have been performed to cope with the issue of power loss. Numerous technologies have been implemented to this end. Network reconfiguration is implemented to deal with such concerns. From the literature survey performed in this field, it is observed that a technique using PSO algorithm is proved to be better than other works. However, there are certain limitations in this technique which raise the need of a novel approach. Thus, this paper presents the design of a novel mechanism that contributes in reducing the power losses in the distribution system. In the proposed approach the process of reconfiguring the network is enhanced by applying the BAT optimization algorithm, as this algorithm has high convergence performance. The model is designed and its performance is determined with respect to voltage profile and fitness value. Simulation is performed in MATLAB environment. The results are obtained and a comparative analysis is performed which ensured that the overall efficacious performance of the proposed system surpasses PSO based network reconfiguration model.**

Keywords: Distribution Network, Power Loss Reduction, Reconfiguration, BAT Optimization Algorithm

I. Introduction

In electrical power system the largest section is of Distribution system. It is that segment of power system that supplies power to different users at their locations in ready to use form. Therefore, providers should assure stable and adequate cost efficient assistance, when they provide power and voltages within the range stated. At everyplace, the distribution network area located to provide power supply to each customer. The system distribution is most appropriate to individual consumer for supplies electricity and dependability, demand, power etc [1].

However, the power loss is main issue in distribution system [2]. Among the world, the transmission and distribution faults in India are highest [3]. The main cause for distribution losses and high transmission in India are inappropriate investment in transmission and distribution system. In 1992-93 the losses was about 19.8% which increased up to 33.98% in 2002. In year of 2009, the loss was near about 27.15%. The current average of total transmission and commercial Loss in India is 28% and large differences in losses are seen in other states.

The classification of losses prevailing in power distribution system is done as [4]:

2. Technical Losses
3. Non-Technical Losses

In figure 1, it has been represented that in the distribution system the loss is calculated as difference of input and output and, there is technical loss and non-technical loss in the system.

Technical Losses: Technical losses are because of energy dissipation that causes due to current passing via conductors and magnetic losses in the transformer. The technical losses that take place while distribution and transmission consists of transformer, substation and line related losses.

Non-Technical Losses: Non-Technical consists of fake absorption of power in bills by meter tampering, setting illegal links on network. Rough idea is made in India that stealing of electric energy is done in crores per year.

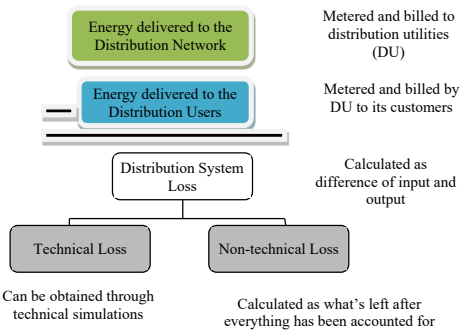

Fig. 1: Types of Losses

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In order to reduce losses, numbers of techniques are used [5], such as:

1. Phase load balance and system reconfiguration.
2. System reconducting
3. Distribution transformers location and dimension.
4. Automatic voltage Booster
5. Reactive Voltage reward
6. Aerial bunch cables
7. High capable transformer
8. High voltage Distribution system
9. Constructing new substation

From these aforementioned techniques, the reconfiguration option is the one which requires low implementation cost for the electricity distribution company, as it permits the utilization of resources already present in the distribution network.

A. Network Reconfiguration:

Distribution networks reconfiguration has recognized as efficient method for system's enhanced performance. Firstly, the network reconfiguration approach was proposed by Merlin and Back for systems loss reduction [6].

In a while, several researches proposed various methods with the goal of loss reduction, service restoration, load balancing, voltage profile improvement. First attempts were limited to the balanced radial network. Newly attempts have reported to implement technique on unbalanced networks also.

In recent years, the low capacity generating sources i.e. Distributed Generation (DG) sources' installation, in the distribution network having low voltage was encouraged because of various reasons. The problem of network reconfiguration has been resolved in cooperation with the solution of capacitor placement issue. Reconfiguration approach was also implemented on distribution system with DG diffusion [7].

To resolve the problem of network reconfiguration, various other different approaches were also proposed.

A significant number of researchers have been performed in the field of distribution systems. A number of technologies are used to this end. A narrative review is performed to understand the advantages and drawbacks of different approaches, which is presented in the next section:

II. Literature Review

In order to resolve the problem of distribution network reconfiguration for minimization of power loss, various approaches were proposed and some of these are discussed below:

For achieving rise in the quality of voltage and fall in the loss of energy, the paper[8] included the introduction of a technique to resolve the issue of re-configuration of network. The manipulation of sequential mechanism called improved simulated annealing that contained random as well as local network improvements, was performed by the introduced technique.

For declining the losses in the power and maintaining profiles of voltage along with the accepted distribution system limits, the utilization of placement of capacitor and network re-configuration has been performed intensively in [7].

The authors [9] represented the study about impacts of configuration of network on the losses of power. For enhancing the quality of power, this mechanism performed redesigning of distribution system.

In paper [10], the author introduced a mechanism with re-configuration and voltage of both high and low levels. For the issue of balance of phase, the introduction of heuristic mechanism was performed during the employment of neural network.

To analyze the re-configuration issue in the distribution system, the author [11] introduced a technique relied on Genetic Algorithm (GA) with the consideration of load variations impact and renewable DGs power generation.

The authors in [12] utilized branch interchange mechanism for declining the losses and tackling the divergent radial configuration issues.

For decreasing the loss, the author [13] represented a detailed study on the re-configuration of network in the power distribution system with the use of DG or dispersed generations

In article [14], a technique relied on AC appropriate power flow issue was introduced with the utilization of ETAP 12.6 software.

I. Atteya, et al., [15] represented the technique to deal with the re-configuration issue of network. In this technique, for the recognition of appropriate distribution networks configuration, MPSO (modified particle swarm optimization) was utilized.

For the purpose of energy loss decline, the paper [35] included the introduction of new optimization mechanism called SSA (salp swarm algorithm) to deal with the re-configuration issue of RDS.

The utilization of CSA (cuckoo search algorithm) was performed in [16] for re-configuration of network in distribution system.

The paper [17] introduced a novel approach whose objective was to decline the loss of power in the distribution networks. This article included the introduction of new technique by utilizing IS-BPSO (Improved Selective Binary Particle Swarm Optimization) to tackle the re-configuration issue of distribution networks. A sigmoid function was offered by the introduced approach. This function could upgrade the overlapping of outcomes and can control the variations in the particles. This approach was considered as the most appropriate one.

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However, this approach uses BPSO approach which consists of several disadvantages that leads to inefficient system.

Therefore, a new approach is required to overcome all the issues of existing system and to provide an efficient system.

III. Present Work

A distribution system delivers electricity to the customers by carrying it from transmission system. Power loss is the major concern in the distribution system for which reconfiguration of network was done. Various methods were introduced in the previous works to resolve the problem of distribution network reconfiguration. In order to resolve this problem, one of the approaches proposed in the previous system was IS-BPSO based approach which was regarded as most appropriate one. However, it consists of various drawbacks such as it can easily fall to the local optimum and its convergence rate is low in the iterative process. These drawbacks lead to inefficiency in the system because speed of convergence is one of the factors of efficiency of method. Also, it needs more computational time.

In order to overcome those issues, the new approach is introduced in the proposed work. In the proposed approach, the BAT algorithm is used for resolving the distribution network reconfiguration problem for minimization of power loss. This algorithm is utilized in the proposed work because it consists of several benefits, among which, the most significant one is that it offers very fast convergence at a very early phase by changing from examination to utilization. As it has quick convergence rate, thus the conventional approach's drawback i.e. low convergence rate, is overcome by using this approach. Also, Bat algorithm possesses the benefit of simplicity and additionally flexibility and it requires less computational time which increases the efficiency of system.

Therefore, the proposed approach leads to an efficient system in which all the previous issues are overcome. This proposed approach is implemented in MATLAB environment to analyze its performance and the results are obtained which are discussed in next section:

IV. Results and Discussions

The proposed system was designed with the aim of minimizing the power consumption and the reconfiguration of the network in bus distribution network. MATLAB environment was use to perform the simulation. The results are calculated in terms of fitness function and voltage profile. The results are obtained and the comparative analysis is carried out to verify the effectiveness of the proposed approach. This section gives a description of the results fetched.

Graph in figure 2 compares the voltage profile. It is revealed from the graph that the voltage profile for proposed work is high as compared to that of traditional approach. The minimum voltage profile for proposed work is accounted nearly 0.95 p.u., it was 0.91 p.u. for existing work. High voltage profile gives better performance. There is a large difference between the values of voltage according to different number of nodes as compared to that to existing work. Fewer variations are observed after reconfiguring the network according to the proposed methodology.

Fitness values achieved for proposed work is then compared with that of the traditional work. The graph is shown in figure 3. The losses are determined for existing IS-BPSO and proposed BAT algorithm according to different number of iterations. The iterations are represented on x-axis and losses are displayed on y-axis. Total 100 iterations are considered and range of losses lies between 80 kW to 170kW. The losses in the traditional system were high whose value accounted to 135 approximately. However, for proposed system it is 120kw. This showed that proposed system is capable of giving better performance.

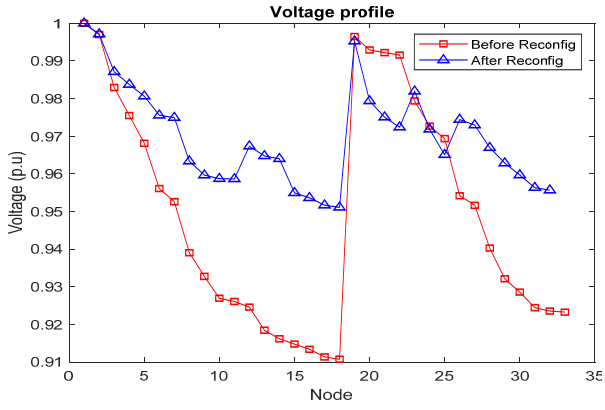

Fig. 2: Comparative Analysis Of Voltage Profile

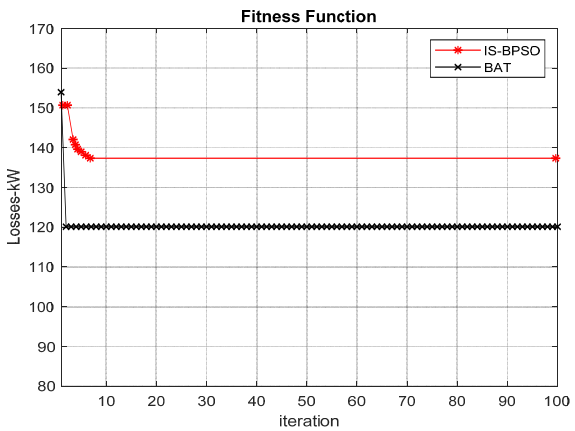

Fig. 3: Comparative Analysis Of Fitness Function

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Also, the comparison is shown with regards to different parameters such as tie, switches, power loss, power loss reduction, and minimum voltage. These values are recorded in a tabular form (table 1) for before and after reconfiguration of the network.

Table 1: Simulation Results of 33 Bus Distribution Network

	Before Reconfiguration	After Reconfiguration
Tie switches	33 34 35 36 37	7 11 14 32 36
Power loss	208.4592 kW	120.0975 kW
Power loss reduction	_____	42.388 %
Minimum voltage	0.91075p.u.	0.9511 p.u.

Power loss is minimized to a vast extent. 42.388% of power reduction is observed. Thus, the overall performance indicates that the proposed system outperformed the outcome of existing work.

V. Conclusion

For distribution network reconfiguration for minimization of power loss, a novel approach is designed in this paper with the aim to resolve the issues of existing system. In this approach, the optimal network reconfiguration is performed. The optimal network performance is achieved by optimizing the whole network. The bus distribution network is deployed by implementing the BAT optimization algorithm. BAT algorithm is implemented due to its various advantages. In order simulate the model, MATLAB environment is utilized. The performance is determined in terms of two factors: Voltage profile and Fitness value. The results obtained are represented graphically and the comparison is performed between the results of the proposed BAT algorithm based model and traditional PSO based approach. The comparative analysis delineated that 42.8% reduction is the power loss is achieved. Along with this voltage profile is increased by 0.4035 p.u.. The reduced value of power loss constituted to 120.0975kW. Thus, the model proposed solved the issue of power loss and helps in increasing the productivity of the distribution system.

References

[01] Mayank Kumar Arjariya, Dr. Amita Mahor, “Modified Distribution Network Using HVDS Techniques”, Int. Journal of Engineering Research and Applications, Vol. 3, Issue 5, Sep-Oct 2013, pp. 1952-1955

[02] L. Ramesh, S. P.Chowdhury, S.Chowdhury, A. A. Natarajan, C. T. Gaunt, “Minimization of Power Loss in Distribution Networks by Different Technique”.

[03] Jigu Parmar, “Total Losses in Power Distribution and Transmission Lines”, August, 19th 2013,https://electrical-engineering-portal.com/total-losses-in-power-distribution-and-transmission-lines-1

[04] “Reduction of Technical and Non-Technical Losses in Distribution Networks” , Working Group on Losses Reduction CIRED WG CC-2015-2 ,20-11-2017

[05] Gurpreet kour , 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

[06] Merlin, A. "Search for a minimum-loss operating spanning tree configuration for an urban power distribution system." Proc of 5th PSCC, 1975 1 (1975): 1-18.

[07] Farahani, Vahid, Behrooz Vahidi, and Hossein Askarian Abyaneh. "Reconfiguration and capacitor placement simultaneously for energy loss reduction based on an improved reconfiguration method" IEEE transactions on power systems 27.2 (2012): 587-595.

[08] S. Koziel, A. L. Rojas and S. Moskwa, "Power loss reduction through distribution network reconfiguration using feasibility-preserving simulated annealing," 2018 19th International Scientific Conference on Electric Power Engineering (EPE), Brno, 2018, pp. 1-5

[09] Raval Vivek, Sanjay R. Vyas, “Distribution System Planning Using Network Reconfiguration For Loss Reduction”, International Research Journal of Engineering and Technology, Volume: 05 Issue: 03, Mar-2018

[10] M. W. Siti, D. V. Nicolae, A. A. Jimoh and A. Ukil, "Reconfiguration and Load Balancing in the LV and MV Distribution Networks for Optimal Performance," in IEEE Transactions on Power Delivery, vol. 22, no. 4, pp. 2534-2540, Oct. 2007

[11] Zidan, Aboelsood, and Ehab F. El-Saadany. "Distribution system reconfiguration for energy loss reduction considering the variability of load and local renewable generation." EnergyM Volume 59, 15 September 2013, Pages 698-707:

[12] E. Zehra, M. Moghavvemi, M. M. I. Hashim and M. Kashem, "Network reconfiguration using PSAT for loss reduction in distribution systems," 2010 1st International Conference on Energy, Power and Control (EPC-IQ), Basrah, 2010, pp. 62-66:

[13] Joon-Ho Choi and Jae-Chul Kim, "Network reconfiguration at the power distribution system with dispersed generations for loss reduction," IEEE Power Engineering Society Winter Meeting. Conference Proceedings (Cat. No.00CH37077), Singapore, pp. 2363-2367 vol.4

[14] N. N. Yin, M. Thuzar and E. P. Thwe, "Analysis of Loss Reconfiguration for Distribution Network System," 2017 21st International Computer Science and Engineering Conference (ICSEC), Bangkok, 2017, pp. 1-5

[15] I. Atteya, H. Ashour, N. Fahmi and D. Strickland, "Radial distribution network reconfiguration for power losses reduction using a modified particle swarm optimisation," in CIRED - Open Access Proceedings Journal, vol. 2017, no. 1, pp. 2505-2508, 10 2017

[16] N. A. A. Fuad, A. A. N. Azlin, M. F. D. Zahari and M. S. A. Hanifah, "Power Distribution Loss Reduction Using Cuckoo Search," 2018 7th International Conference on Computer and Communication Engineering (ICCCE), Kuala Lumpur, 2018, pp. 333-337

[17] Raoni Pegado, et al., “Radial distribution network reconfiguration for power losses reduction based on improved selective BPSO”, pp 2016-213, 2019.

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