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# An Experiment Approach to Transmission Loss Optimization Using Power

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***Abstract*—** The distribution systems must be able to provide energy/electricity to each consumer at an appropriate form of voltage rating. The modern forms of power are complex in nature with multiple load centres and generating stations interconnected through the transmission and distribution networks. The main objective of the energy based power system is energy generation and to deliver the energy/power at to its customers at its rated voltage-based value with minimum losses. In case of heavy loading condition, the reactive form of power flow is the major cause of losses, thus reducing the levels of voltage simultaneously. So, there is occurs a big need to minimize real losses of power and to improve the level of voltage in distribution systems. In such cases, a variation occurs in the network configuration usually varying by the operation based on switching meant for transferring the load among the feeders. Basically there are two switches used in distribution systems; one is normally closed switch that usually connects two line-based sections and the other is the normally open switch placed on tie lines connecting two of the primary feeders in the section.The optimized form of network configuration represents a topological feeder structure by changing the open/closed sectionalizing status and tie-line switches with minimized losses, saving the distribution system radial structure.

***Keywords-*** *losses, power, optimization, distribution.*

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## I. Introduction

The energy plays a vital role for all the humans as the it can neither be created nor it get destroyed but it can move/transform from one place to other. The modern living has realized the increased importance of energy as the life is moving faster, there is big need for fast communication, fast transport and manufacturing processes. So, energy industry forms one of the biggest consumer market. The use of electric power system requires an alternative generation because of its large demand by the consumers. The electricity cost is calculated based on different proportions such as 50% for fuel consumption, 25% for distribution, 20% for generation, and % for transmission which has created an alert to use or generate the alternative resources of power. For the levels of distribution, the ratio of reactance to resistance (X/R) is low when compared to levels of transmission which has resulted in high power losses and voltage magnitude dip along the distribution (radial) lines. The distribution systems must be able to provide energy/electricity to each consumer at an appropriate form of voltage rating.The modern forms of power are complex in nature with multiple load centres and generating stations interconnected through the transmission and distribution networks.

## II. PROPOSED WORK

The increasing load demand requirement, the process of distributed generation (DGs) is integrated into distribution systems. In power distribution network, the increased load demands is the major cause for the distribution systems to operate very closely to boundaries of voltage instability. When the DG units get integrated into distribution system, the network experiences various impacts based on its parameters such as power quality, power flow, voltage profile, stability, protection, and reliability. The problem of voltage stability and load flow loss are the major challenges for the power industry. In power distribution system, the issue of voltage instability is related to dynamics of the load flow, thus it requires distinct forms of load characteristics to deal with voltage stability as well the losses occurring during its process analysis. In modern electrical power systems, the injection of reactive power plays a significant role in power or load flow analysis and control of voltage stability, thus the losses based on reactive power are required to get incorporated in DG optimization process in order to improve the voltage profile. Many algorithms have been proposed to emphasize load flow losses and improve the voltage profile of the system. The proposed work involves the use of Grey Wolf Optimization (GWO) algorithm employed for obtaining restructured power distribution network (PDS) and helps in identification of optimal switches/transforms corresponding to power (minimum) loss in distribution network systems.

### PROBLEM FORMULATION

Important area in which distribution automation is being applied is the area of network reconfiguration. Network reconfiguration refers to the closing and opening of switches in a power distribution system in order to alter the network topology, and thus the flow of power from the substation to the customers. There are two primary reasons to reconfigure a distribution network during normal operation. Depending on the current loading conditions, reconfiguration may become necessary in order to eliminate overloads on specific system components such as transformers or line sections. In this case it is known as load balancing.

1. As the loading conditions on the system change it may also become profitable to reconfigure in order to reduce the real power losses in the network. This is usually referred to as network reconfiguration for loss reduction and is the topic of this thesis.
2. Network reconfiguration in both of these cases can be classified as a minimal spanning tree problem, which is known to be an NP–complete combinatorial optimization problem. A method is needed to quickly find the network configuration which minimizes the total real power loss of the network while satisfying all of the system constraints.
3. Several approaches have been applied to the solution of this problem with varying degrees of success. Heuristic methods have been used successfully to find sub-optimal solutions rapidly. The genetic algorithm and simulated annealing which require much more computation time, have been used to find optimal solutions.

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## III. METHODOLOGY

This section describes the detail methodology of the proposed work which includes the algorithm used and flow chart of the work. The optimization has been performed by using Grey Wolf Optimization algorithm which is based on the biological behavior.

**ALGORITHM**

Grey Wolf Optimization: It is a meta-heuristic algorithm which simulates the leadership hierarchy and hunting behavior of wolves. The fitness of the wolves measured in the form of alpha, beta and delta. The figure 1.2 given below shows the hierarchy level of the wolves.

Grey wolves have the ability of memorizing the prey position and encircling them. The alpha as a leader performs in the hunt. For simulating the behavior of grey wolves hunting in the mathematical model, it is assumed that the alpha ($\alpha$) is the best solution, the second optimal solution is beta ($\beta$) and the third optimal solution is delta ($\delta$). Omega ($\omega$) is assumed to be the candidate solutions. Alpha, beta and delta guides the hunting while position is updated by the omega wolves by these three best solutions considerations.

**Encircling prey**

Prey encircled by the grey wolves during their hunt. Encircling behavior in the mathematical model, below equations is utilized.

$$\vec{A}(T+1) = \overrightarrow{A_P}(T) - \vec{X}.\vec{Z}$$

$$\vec{Z} = |\vec{Y}.\overrightarrow{A_P}(T) - \vec{A}(T)|$$

Where,

$\vec{Z}$ and $\vec{X}$ are vectors that are calulated by above given equation.

T$\leftarrow$iterative number

$\vec{A}\leftarrow$grey wolf position

$\overrightarrow{A_P}\leftarrow$prey position

$$\vec{X} = 2x.\vec{r_1} - x$$

$$\vec{Y} = 2\vec{r_2}$$

**HUNTING**

For grey wolves hunting behavior simulation, assuming $\alpha$, $\beta$, and $\delta$ have better knowledge about possible prey location. The three best solutions are firstly considered and then $\omega$ (other search agents) are forced for their position update in accordance to their best search agent position. Updating the wolve's positions as follows:

$$\vec{A}(T+1) = \frac{\vec{A_1} + \vec{A_2} + \vec{A_3}}{3}$$

Where $\vec{A_1}, \vec{A_2}, and\ \vec{A_3}$ are determined,

$$\vec{A_1} = |\vec{A_\alpha} - \vec{X_1}.Z_\alpha|$$

$$\vec{A_2} = |\vec{A_\beta} - \vec{X_2}.Z_\beta|$$

$$\vec{A_3} = |\vec{A_\delta} - \vec{X_3}.Z_\delta|$$

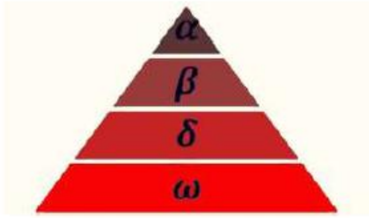


Figure 1:Hierarchy levels of the wolves

1) The first level wolver are called are alpha wolves which are dominant in nature and all other wolves follow their orders. Alpha are the best decision makers having the best fitness value in the whole pack and are also the leaders of the pack
2) The second level wolves are the beta wolves and also called as subordinate wolves which help in decision making in alpha and also the other members of the pack.
3) The third level wolves are the delta wolves which work after the beta wolves. Delta wolves are considered when the beta wolves are not working properly. These wolves are also called as scouts.
4) The fourth and the last level of the hierarchy are related to the omega wolves. Omega wolves have low fitness value and are considering at the last. Omega wolves are also known as scapegoats.

## IV. RESULTS AND DISCUSSION

This section presents the result and discussion of the proposed work in the graphical form. These graphs are generated in the simulation environment which is use to evaluate the performance of the proposed work over the existing work. The performance evaluation is done on the basis of below given parameters.

**Result of BAT and PS on 3 buses**

| Cost (PROPOSED) (RS) | Cost (BAT)(RS) | Loss (PROPOSED)(W) | Loss (BAT) (W) |
|---|---|---|---|
| 26954.61 | 26969.7 | 0.51 | 0.052 |
| 10165.187 | 10170.88 | 0.046 | 0.049 |
| 9153.287 | 9158.411 | 0.038 | 0.04 |

Table 1: Cost and Loss on 3 Buses

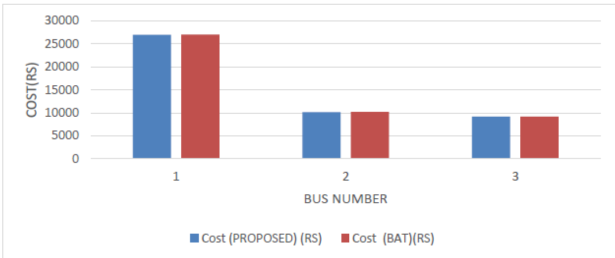


Figure 2: Cost graph of 3 Buses

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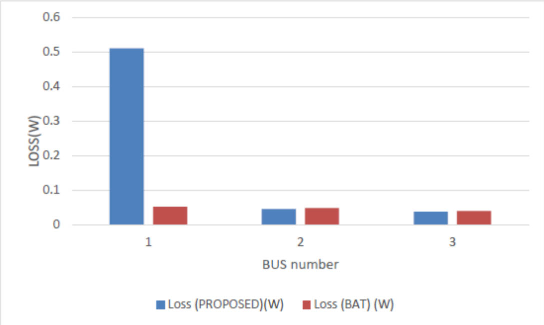


Figure 3: Loss graph on 3 Buses

**Result of BAT and Proposed on 30 buses**

| Sr. No | Cost (Pro | Cost (BAT)( | Loss (PRO POSE | Loss (BAT) |
|---|---|---|---|---|
| 1 | 144744.57 | 144825.63 | 0.005 | 0.06 |
| 2 | 21047.703 | 21029.49 | 0.071 | 0.073 |
| 3 | 14170.601 | 14178.537 | 0.011 | 0.012 |
| 4 | 1034.798 | 1035.377 | 0.013 | 0.015 |
| 5 | 2688.1 | 2689.605 | 0.082 | 0.09 |
| 6 | 616356.04 | 616365.19 | 0.023 | 0.03 |
| 7 | 4528.61 | 4531.146 | 0.002 | 0.005 |
| 8 | 2358.976 | 2360.297 | 0.004 | 0.006 |
| 9 | 3373.293 | 3375.184 | 0.001 | 0.002 |
| 10 | 1196.913 | 1197.583 | 0.034 | 0.045 |
| 11 | 1115.958 | 116.582 | 0.021 | 0.025 |
| 12 | 6703.531 | 6707.285 | 0.005 | 0.056 |
| 13 | 4109.99 | 412.297 | 0.008 | 0.009 |
| 14 | 923.187 | 923.704 | 0.0021 | 0.004 |
| 15 | 1617.848 | 1618.754 | 0.002 | 0.005 |
| 16 | 20259.631 | 20270.976 | 0.004 | 0.006 |
| 17 | 265.222 | 265.37 | 0.006 | 0.007 |
| 18 | 309.821 | 309.994 | 0.002 | 0.001 |
| 19 | 856.44 | 856.919 | 0.004 | 0.002 |
| 20 | 224.864 | 224.989 | 0.0023 | 0.0043 |
| 21 | 10.928 | 10.934 | 0.007 | 0.008 |
| 22 | 54.47 | 54.509 | 0.006 | 0.007 |
| 23 | 159.117 | 159.206 | 0.005 | 0.006 |
| 24 | 20.264 | 20.264 | 0.007 | 0.008 |
| 25 | 67.651 | 67.685 | 0.011 | 0.012 |
| 26 | 360.85 | 361.093 | 0.023 | 0.042 |
| 27 | 74.855 | 74.91 | 0.024 | 0.034 |
| 28 | 473.016 | 473.281 | 0.026 | 0.037 |
| 29 | 213.985 | 213.605 | 0.004 | 0.006 |
| 30 | 2.687 | 2.688 | 0.006 | 0.007 |

Table 2: Cost and Loss on 30 Buses

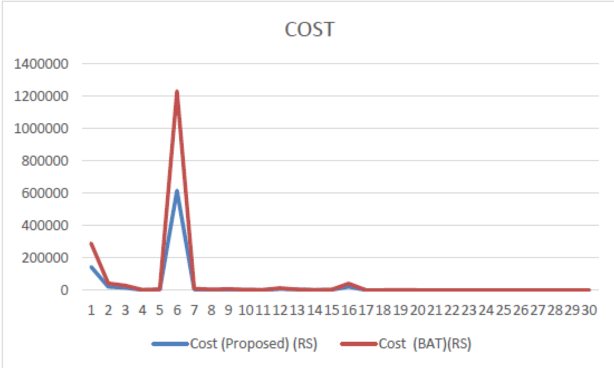


Figure 4: Cost of 30 buses on BAT and PS

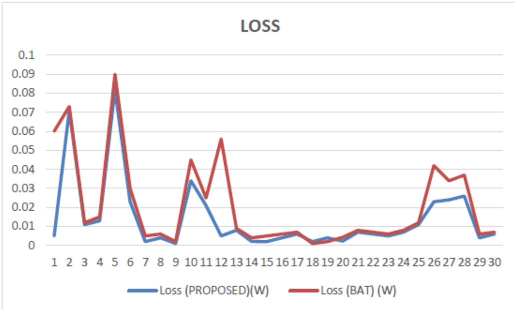


Figure 5: Loss on 30 Buses using BAT and PS

**Result of BAT and Proposed on 40 buses**

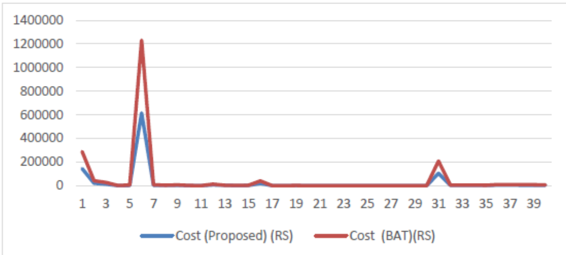


Figure 6: Cost (Proposed) (RS) and (BAT)(RS)

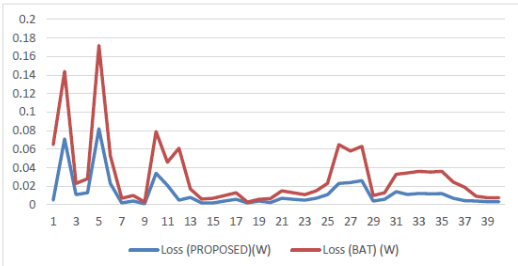


Figure 7: Loss (Proposed) (W) and Loss (BAT)(W)

## V. Conclusion

The worldwide issue of lower availability of power to the users is theresult of loss of power and no matter how attentively the network of power system is modelled or designed, losses are not avoidable. The overall losses value isadequately known as well as their expected source. However, what the location and magnitude of such sources remain unexplained. The literature of the research basically acknowledge distinct type of approaches on the basis of loss estimation but the already existing approaches mainly focus on probabilistic data and theoretical calculation, incomplete to provide an accurate evaluation-based loss assessment. The major goalof the research workis basically to develop a new approach for assessing the transient i.e. for highdegree on the basis of accuracy and steady value of technical losses over power line. In this thesis, the evaluation approach of power line loss in its implemented form is usually used in development of a methodology that determined problem of distinct areas over the test system like, high line current magnitude, current unbalance, violated high and low voltage buses. On the basis of such type of findings, the further research studywas used for exploring the measures of loss mitigation in the test system, firstly, by injection of capacitive shunt-based compensation which further reduced the amount of power line losses, thereby improving the performance and efficiency of the power line. Another loss mitigation segment measure the fault magnitude current for 3-Φ short-circuit which got simulated in around 28 locations that was for calculating the ratings of circuit breaker (33 bus) in the test system. In addition, the analysis result of single line contingency for compensated and uncompensated was carried out over the network in order to verify the loosing effect of any of the powerline.

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