Abstract

In this paper, multi-objective distribution network reconfiguration with the objectives of minimizing the actual losses and improving power quality parameters is carried out. For this purpose, binary genetic algorithm (BGA) optimization procedures with the help of weighted sum method used. Along with these algorithms, graph theory and the adjacency matrix of the graph corresponds to the distribution network, to investigate the constraints and objective functions such as the reconfiguration of the radial transmission and distribution networks can be used all over again. All the algorithms and methods on a standard 33-bus IEEE distribution network have been studied and implemented.

Keywords: Reconfiguration, Power Quality, Binary genetic algorithm (BGA)

1- Introduction

Reconfiguration was first discussed in 1975 in order to reduce active power losses in distribution networks [1] was proposed. In this paper, first of all keys in the distribution package is not intended to replace the various branches, the proper response is reconfiguration. The main disadvantage of this study can be assumed to be active all over again and ignoring the network constraints such as voltage and limits the current through each branch could be mentioned. In [2] branch switching methods for solving reconfiguration selecting two to two branches, one for each ring opening and the closing have been selected to have been developed by . The disadvantages of this method can be too time solving reconfiguration noted. In [3] studied a network reconfiguration of a seasonal or daily (function of time) and at various times has been made. In [4] an innovative approach to automatically remove unwanted keys to choose which leads to non-radial networks are presented. In this paper, only the total radioactive waste problem has been selected as the target network. In [5] and [6] for the first time, the ant algorithm to rearrange distributed systems with the goal of reducing the losses can be utilized. This algorithm is very suitable solutions for problems such as traveling salesman problem and provides a sequential order. The excellent results of the ant algorithm to solve the problem reconfiguration has to offer. In [7], the ant algorithm for parallel search feeders to minimize losses and to improve voltage levels are used. Than the benefits of parallel search to reduce the computation time can be noted. In this paper, the network is much less able to find global minimum . In [8] an innovative approach to problem solving migration reconfiguration using ant colony algorithm is presented. Login nonlinear loads in the power distribution network can have a negative impact on the quality issue. One way to improve the power quality parameters are reconfiguration [9]. Therefore, one goal of reconfiguration can improve power quality parameters, such as voltage harmonics. In this paper, multi-objected reconfiguration of distribution networks in order to reduce losses and improve power quality parameters using intelligent methods is studied. Also, using other definitions and properties of the adjacency matrix of graph theory, graph constraints and objective functions are evaluated.
2- Introduction of objective functions

The reconfiguration of the studied networks using weighted sum method to optimize multi-purpose, three functions is used for the purpose stated in the previous chapters. The relations (1) to (3) these relationships are re-created.

\[
F_1 = \sum_{i=1}^{n_pcc} \sum_{j=1}^{n_l} \left| v_{i,j} \right|^2
\]

(1)

\[
F_2 = \sqrt{\sum_{i=1}^{n_pcc} THD_i^2}
\]

(2)

\[
F_3 = P_{loss}
\]

(3)

In these equations:

- \( i \in \{ \) The total number of network buses \}
- Constraints in the objective function in (2) are observed. However, a separate radial bus network and lack of reconfiguration are major constraints.

\[
V_{min} \leq |V| \leq V_{max}
\]

\[
|I_b| \leq I_{b,\text{max}}
\]

(4)

- \( I_b \): The current of b-th branch
- \( R_b \): The resistance of b-th branch
- \( N_j \): The total number of network branches
- \( I_b^R \): The maximum current through b-th branch
- \( V_i \): The magnitude voltage of i-th bus

The first and second objective functions in order to improve power quality parameters and the third goal is to reduce active power losses are defined. The purpose of this paper is that each objective functions to be minimized simultaneously. But given that these three functions have different dimension and thus cannot be directly these three functions together, he would become a target function. To resolve this problem, the method of weighting coefficients is proposed.

3- The method of weighting coefficients

For reconfiguration problem solving with weighted coefficients of the objective function is suggested:

\[
F = W_1 \cdot \sqrt{\sum_{i=1}^{n_pcc} \sum_{j=1}^{n_l} \left| v_{i,j}^{\text{sat}} \right|^2} + W_2 \cdot \sqrt{\sum_{i=1}^{n_pcc} THD_i^2} + W_3 \cdot P_{loss} + C
\]

(5)

In this formula \( w_1, w_2, \) and \( w_3 \) are the weighting coefficients and \( C \) is the penalty factor.

This approach to solving the problem of dimension per unit order to provide an objective function \( F_3 \). This will solve the problem dimension. However, with the proper choice of weighting coefficients \( w_1 \) to \( w_3 \) affect any of these functions, we determine the target. This usually allows the operator to choose the coefficients of the objective function, which is more important to look at the highlight.

Given the constraints that the rearrangement of the distribution networks, such as the preservation of the radial system serves all loads placed on each bus voltage and current of each branch, there is a range of acceptable answers must violate the provisions of can be removed from the set of solutions. Therefore, the parameters in each of the objective functions is considered to be as follows:
Equation (6), and the coefficients are penalized for incorrect choices. Penalty factor for the number of meshes
penalty factor for the number of buses isolated network and system requirements.
Put the parameters in the objective functions and possible solutions improbable been removed from the search
space and the algorithm quickly converges to the optimum solution is better. It is worth noting constraints and
lack of bus radial network isolation system using graph theory are confirmed.

4- SIMULATION RESULTS:

In this section, the objective binary genetic algorithm (BGA) are implemented [10]. The system used a 33-bus
distribution system with rated voltage 12.66 kV is [11]. Single-line diagram of this system is depicted in the
figure 1. Also assumed to be non-linear loads in Table 1 are in the network.

Before performing the simulation assumes that the keys are open lines 33-37. It also has loads of bass that are
sensitive to voltage dips and harmonics are: (12, 20, 24, 28). In this case, the objective values of the quality
parameters are as follows:

\[
\text{fit1} = \sqrt{\sum_{i=1}^{n_{pcc}} \sum_{j=1}^{n} |s_{ij}|^2} = 14.4083
\]

(7)

\[
\text{fit2} = \sqrt{\sum_{i=1}^{n_{pcc}} THD_l^2} = 0.2906
\]

(8)

The implementation of this algorithm in networks with BGA due to mesh networks due to the closure of all five
keys, a gene on chromosome 5 have been considered. Each chromosome [Key1, Key2, Key3, Key4, Key5] is
defined. The program repeats on chromosome number 20 and number 200 is selected by the algorithm. Cross over rate against 0.9, the mutation ratio 0.05 is selected. In the first case, the coefficients for the intended purpose and penalty functions are: and \(w_3=1\). Implementation results in Table 2 and Figures (2) and (3) are summarized.

![Fig2. Convergene characteristics of BGA](image)

<table>
<thead>
<tr>
<th>Fitness value after reconfiguration</th>
<th>Selected branches</th>
<th>Fitness value before reconfiguration</th>
<th>Improvement percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>(F_2=10.4627)</td>
<td>11,7,22,35,20</td>
<td>14.4083</td>
<td>27.38</td>
</tr>
<tr>
<td>(F_3=0.0352)</td>
<td></td>
<td>0.2906</td>
<td>87</td>
</tr>
<tr>
<td>(F_1=1.1307)</td>
<td></td>
<td>2.0268</td>
<td>44.21</td>
</tr>
</tbody>
</table>

Single-line diagram of the system after rearrangement is depicted in the figure 3. This figure shows the radial and interconnected networks remains after rearrangement. The radial limits are being adhered systems. And the optimization method converges to the right answer.

![Fig3. 33 bus test System after reconfiguration(at the first case)](image)

In this section, three factors were considered equal to 1. But convenience is not possible to adjust these coefficients. Secondly usually farmers tend to have a bunch of good answers to choose from among the best answer rather than simulation program where decision. Continuing to operate the system assumes that to reduce
losses are more important than any other objective function. In this case, for example, the weighting coefficients can be considered as follows:

\[ w_1 = w_2 = 1, \quad w_3 = 10 \]

By choosing the weighting coefficients, and the simulation results obtained are as follows. The Table 3 shows a loss of about 87.90% drop. However, they have had less improvement in the objective function. By increasing the weighting coefficients associated with the third objective function, the objective function compared to others in the objective function is reduced further. This topic shows how to change the weighting coefficients in the final solution is an effective optimization algorithm. This makes it very difficult to choose the coefficients. Single-line diagram of the system, however, is depicted in Figure 4. This figure shows the radial and interconnected networks remains after rearrangement. The radial limits are being adhered systems. And the optimization method converges to the right answer.

### Tabale 3. The results of reconfiguration (the second case)

<table>
<thead>
<tr>
<th>Fitness value after reconfiguration</th>
<th>Selected branches</th>
<th>Fitness value before reconfiguration</th>
<th>Improvement percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F_2 = 11.0644 )</td>
<td>27 23 24 8 35</td>
<td>14.4083</td>
<td>23.20</td>
</tr>
<tr>
<td>( F_3 = 0.02653 )</td>
<td></td>
<td>0.2906</td>
<td>90.87</td>
</tr>
<tr>
<td>( F_1 = 0.7653 )</td>
<td></td>
<td>2.0268</td>
<td>62.05</td>
</tr>
</tbody>
</table>

![33 bus test System after reconfiguration (at the second case)](image)

In the third case, the weighting coefficients is selected as follow:

\[ w_1 = w_3 = 1, \quad w_2 = 10 \]

By choosing the weighting coefficients and the simulation results are obtained in Table 4.

### Tabale 4. The results of reconfiguration (the third case)

<table>
<thead>
<tr>
<th>Fitness value after reconfiguration</th>
<th>Selected branches</th>
<th>Fitness value before reconfiguration</th>
<th>Improvement percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F_2 = 10.4535 )</td>
<td>27 24 33 35 11</td>
<td>14.4083</td>
<td>27.44</td>
</tr>
<tr>
<td>( F_3 = 0.0352 )</td>
<td></td>
<td>0.2906</td>
<td>87.88</td>
</tr>
<tr>
<td>( F_1 = 1.2422 )</td>
<td></td>
<td>2.0268</td>
<td>38.71</td>
</tr>
</tbody>
</table>
The Table 4 shows that the objective function is about 44.27% drop compared to the previous two cases have been reduced. In fact, increasing the weight coefficients of the objective function, the objective function in the optimization problem has been further reduced. Single-line diagram of the system after rearrangement in this case is depicted in Figure 5. This figure shows the radial and interconnected networks remains after rearrangement. The radial limits are being adhered systems. And the optimization method converges to the right answer.

Above discussion shows that the choice of weighting coefficients in solving multi-objective optimization problems are of particular importance. And changes in these coefficients will be significant changes to optimize the output response.

5- Conclusions

In this paper, multi-objective distribution network rearrangement aims to reduce losses and improve power quality parameters were measured. For this purpose, a multi-objective problem into a single objective using weighting coefficients were converted and analyzed using binary genetic algorithm. To demonstrate the effectiveness of the proposed method 33 bus IEEE test system was used.

References