Improved Reconfiguration Algorithm by using an Initial Operating Point in Distribution Power System

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Keywords: distribution power system, system reconfiguration, loss minimization, initial operating point

The normal operation of a distribution power system is done based on the necessity for loss minimization of power and the load balance of the transformer, and etc. This includes improved reconfiguration which is a method of determining the lines on/off status while considering the constitution of the current distribution power system and the load status.

The object function for loss minimization is defined as Eq. (1).

\[
\text{Minimize } P_{\text{loss}} = \text{Minimize } \left( \sum r_i P_i^2 + Q_i^2 V_i^2 \right) \text{ [pu]} \tag{1}
\]

In order to minimize the loss of the power system, an object function concerning each structure is calculated, and the most appropriate structure in these results is adopted.

In the earlier studies, it was solved by branch and bound method and branch exchange method. These methods have considerable calculating speed however they have a problem which is that the local optimal solution is dependent on the early status of the sectionalized switch.

While simulated annealing algorithm, genetic algorithm to improve this demerit, has merit because it provides a global optimal solution, it also has a problem that takes a long time to calculate.

This paper shows that reconfiguration is applied by branch exchange in order to reduce the calculation time.

In Fig. 1, if a sectionalized switch b is closed, the operation condition of the radial structure in the distribution power system is contrabuted due to it constituting a loop structure. Therefore, either the sectionalized switch on the L side or the sectionalized switch on the R side should be opened.

During the process, loss minimization is estimated depending on the line’s on/off status, in power system, resulting from it, a method that performs line’s on/off for the loss minimization is called branch exchange.

And an algorithm was added in order to find a high quality solution or optimal solution by changing the initial operation status, in case the current distribution power system is not operated in adjacent high quality solution or optimal solution. Hence, this paper suggests a method that prevents the branch exchange from miscalculation as local solution.

Figure 2 shows that if the initial open state of tie-line which was moved near high quality solution or optimal solution is applied to the improved reconfiguration algorithm, the desired high quality solution or optimal solution is obtained.
Improved Reconfiguration Algorithm by using an Initial Operating Point in Distribution Power System

Gyu-Seok Seo* Non-member
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This paper shows a method that reconfigures the distribution power system by using branch exchange algorithm. The optimal reconfiguration method calculates line loss and voltage condition in all possible power system configurations depending on line on/off, and it searches for the most appropriate optimal configuration. However, it is not easy to search for the solution for the most appropriate optimal configuration in distribution power system for a short time because there are a number of connection & sectionalized switches in distribution power system and it should comply with the condition of radial operation. Therefore, this research shows the method that not only reduces the whole system loss by using branch exchange algorithm which has the advantage in time, but also complies with the condition of radial operation and the constraint condition of voltage.

Keywords: distribution power system, system reconfiguration, loss minimization, initial operating point

1. Introduction

The normal operation of a distribution power system is operated on the purpose of loss minimization of power and the load balance of the transformer, and so on, and the problem of the optimal reconfiguration is the one that decides the line’s on/off state considering the configuration of current distribution power system and the load status.

This problem accompanies some constraint conditions that include the radial operation condition, voltage drops, and the line’s capacity, it calculates the line loss and voltage conditions for all possible power system configurations that are dependent upon the line on/off and searches for the optimal configuration among them.

Therefore, the most appropriate method to obtain the solution is to search for it on the basis of the calculating all cases. However, calculating all possible cases within the limited time is unreasonable in the aspect of time-consuming.

In the earlier studies, the study of optimal reconfiguration was solved by branch and bound method and branch exchange method (9–11),

These methods have the advantage that the rate of calculation is fairly fast. However, in case that the initial operation system operates near the optimal operation point, the optimal operation point can be easily found; but otherwise, they also have the disadvantage that it cannot be found and converges at the local optimal solution.

It means that because the operation point in actual distribution power system generally operates near the optimal operation point, previously mentioned algorithms can be applied. However, in case that the operation point is far away from the optimal point, the optimal operation point cannot be found. Accordingly, in the position of distribution operator, the reliability of solution is low.

As for the algorithm improved that, there are simulated annealing algorithm, genetic algorithm, and Hybrid Differential Evolution algorithm (8) (10) (12) (13).

While there is an advantage that provides the global optimal solution regardless of the initial status of system, these also have a disadvantage that it takes a long time to calculate.

This paper suggests the algorithm that can solve some problems that cannot search for the optimal operation point depending on the initial status of system and it takes long time for the solution to be calculated.

The algorithm suggested in this paper uses the Branch exchange algorithm that is basically calculated the fastest.

However, because Branch exchange algorithm can have the solution that can be changed according to the initial status of system, to solve this above problem, the initial operation point algorithm is added to move the initial status of system to near a high quality solution.

In other words, by applying the initial operation point algorithm before applying Branch Exchange algorithm, the power system is moved near a high quality solution, after that, Branch Exchange algorithm is applied and a high quality solution can be obtained.

This algorithm is the one that have a chance to search for the global optimal solution by changing the initial operation status in case that the current distribution power system doesn’t operate near the optimal operation point, hence, it prevents Branch Exchange algorithm from calculating a local optimal solution.

In addition, it has the advantage that speed is considerably fast because it is based on the Branch Exchange algorithm.

To verify the excellence of the suggested algorithm that has the above characteristics, the result that only the existing branch exchange algorithm was applied and that of the new algorithm combined by the initial operation point algorithm and branch exchange algorithm are compared by applying it.
to the distribution power system that has 32 buses. To obtain more concise results, the results are observed by applying this suggested algorithm to the more enlarged distribution power system that has 83 buses.

VSHDE algorithm that has a high quality solution with stochastic search method from existing papers is applied to 83-bus model (12).

In this paper, by comparing the result that calculated by suggested algorithm and the result that calculated by VSHDE algorithm, the excellence of suggested algorithm is proved.

2. Expression of Distribution Power System

The distribution power system is operated by a radial structure, however, its real power system is made up of loop structures. As these structures changes depending on the line being on/off, to express them requires much effort and it is not easy to express them as a program. This paper suggests a method that shows the line connectivity by using OOP (Object oriented programming) and easily corresponds to the changes of system structures.

Figure 1 schematizes the feeder object and a feeder has a pointer connecting other line objects in order to decide the system topology with the data that is basically needed to be calculated. Through this process, the delivery of messages is done on each object.

In addition to this, the Node, DLine, Load, and Transformer are constituted, and the entire program is made up of the delivery of messages of interaction of objects using connection status and member functions.

Figure 2 shows the realization of the system created in order to correspond to the real distribution power system by using objects mentioned above.

3. Branch Exchange Algorithm

3.1 Formulation of the Problem

The object function for loss minimization is defined as Eq. (1).

\[
\text{Minimize } P_{\text{loss}}^{\text{opt}} = \text{Minimize } \left( \sum_{i} r_i \left( P_i^2 + Q_i^2 \right) \right) \text{[pu]} \quad \cdots \cdots \cdots \cdots \cdots \cdots (1)
\]

In order to minimize the loss of the power system, an object function concerning each structure of the system is calculated, and the most appropriate structure of these results is adopted. As a real power system operation is empirically operated near the global optimal solution, Branch Exchange, the most excellent in exploring local optimal solutions, is done for loss minimization.

3.2 Estimation of Loss Minimization in Changing Line On/Off

There is a distribution power system that is operated radially such as Fig. 3 (6).

In Fig. 3, if a sectionalized switch b is closed, loop system is constructed and it violates the operation condition of radial structure in distribution power system, therefore, the sectionalized switch either on L side or on R side should be open.

During this process, line loss that depends on line’s on/off is estimated, and this method is called Branch Exchange Algorithm that performs line’s being on/off concerning connection lines that makes loss minimized.

In Fig. 3, the loss of power system both on L side and on R side is shown in Eqs. (2), (3).

\[
LP_L = \sum_{l \in L} r_l (P_l^2 + Q_l^2) \quad \cdots \cdots \cdots \cdots \cdots \cdots (2)
\]

\[
LP_R = \sum_{l \in R} r_l (P_l^2 + Q_l^2) \quad \cdots \cdots \cdots \cdots \cdots \cdots (3)
\]

In case that line b is OFF and m is ON, the change of loss is shown in Eq. (4).

\[
\Delta P_{\text{loss}}^{\text{est}}_{bm} = 2P_m \left( \sum_{l \in L} r_l P_l - \sum_{l \in R} r_l P_l \right) + 2Q_m \left( \sum_{l \in L} r_l Q_l - \sum_{l \in R} r_l Q_l \right) - \left( P_m^2 + Q_m^2 \right) \sum_{l \in R \cup L} r_l \quad \cdots \cdots \cdots \cdots \cdots \cdots (4)
\]

In Eq. (4), \( \Delta P_{\text{loss}}^{\text{est}}_{bm} > 0 \) means the loss is reduced in case of
changing line’s on/off state.

After calculating $\Delta P_{\text{est}}^{\text{best}}$ from each tie-line, line’s on/off state should be changed until there is no loss reduction. The optimization by branch exchange is performed in the order of Fig. 4.

### 3.3 Results of Algorithm Application

The method suggested by Fig. 4 was applied to the system shown in both Table 1 and Fig. 5.

Figure 5 consists of the distribution power system model configured by the data given by Table 1 and also consists of 32 nodes and 37 branches.

The result of this simulation is shown in Table 2 and it is found that this result is a better solution compared with the results of exiting papers.

However, Table 2 is the result from the assumption that general distribution power system condition is empirically operated near a high quality solution. In real distribution power system, sometimes operation point isn’t operated near a high quality solution, and this is expressed by changing base case in Table 2 into base case in Table 3.

Table 3 shows the result of being simulated not near a high quality solution. So it is found to be not better than that of Table 2 that was operated near a high quality solution in power system loss and voltage characteristic.

---

**Table 1. Power system’s data for simulation**

<table>
<thead>
<tr>
<th>Line No.</th>
<th>From Bus</th>
<th>To Bus</th>
<th>$R(\Omega)$</th>
<th>$X(\Omega)$</th>
<th>Load at To Bus (kW)</th>
<th>Load at To Bus (kVAR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0.0922</td>
<td>0.0477</td>
<td>100</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>3</td>
<td>0.493</td>
<td>0.2511</td>
<td>80</td>
<td>40</td>
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<td>3</td>
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<td>0.1864</td>
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<td>80</td>
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<td>0.1941</td>
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<td>7</td>
<td>7</td>
<td>8</td>
<td>1.7114</td>
<td>1.2351</td>
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<td>100</td>
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<td>0.74</td>
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<td>20</td>
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<td>0.1966</td>
<td>0.065</td>
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<td>30</td>
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<td>12</td>
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<td>0.1238</td>
<td>60</td>
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<td>12</td>
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<td>1.468</td>
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<td>14</td>
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<td>15</td>
<td>0.5463</td>
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<td>0.1565</td>
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<td>0.9373</td>
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<td>21</td>
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<td>0.9337</td>
<td>60</td>
<td>20</td>
</tr>
<tr>
<td>22</td>
<td>22</td>
<td>23</td>
<td>0.7463</td>
<td>0.545</td>
<td>60</td>
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<td>0.545</td>
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<td>24</td>
<td>24</td>
<td>25</td>
<td>0.898</td>
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<td>200</td>
</tr>
<tr>
<td>25</td>
<td>25</td>
<td>26</td>
<td>0.898</td>
<td>0.7091</td>
<td>420</td>
<td>200</td>
</tr>
<tr>
<td>26</td>
<td>26</td>
<td>27</td>
<td>1.059</td>
<td>0.9337</td>
<td>60</td>
<td>20</td>
</tr>
<tr>
<td>27</td>
<td>27</td>
<td>28</td>
<td>0.8042</td>
<td>0.7006</td>
<td>120</td>
<td>70</td>
</tr>
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<td>28</td>
<td>28</td>
<td>29</td>
<td>0.5075</td>
<td>0.2585</td>
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<td>600</td>
</tr>
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<td>29</td>
<td>29</td>
<td>30</td>
<td>0.9744</td>
<td>0.963</td>
<td>150</td>
<td>70</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
<td>31</td>
<td>1.015</td>
<td>0.9619</td>
<td>210</td>
<td>100</td>
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<td>32</td>
<td>0.341</td>
<td>0.5002</td>
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<td>40</td>
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<tr>
<td>32</td>
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<td>33</td>
<td>0.0000</td>
<td>2.0000</td>
<td>60</td>
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<td>40</td>
</tr>
<tr>
<td>34</td>
<td>34</td>
<td>35</td>
<td>0.0000</td>
<td>0.5</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>35</td>
<td>35</td>
<td>36</td>
<td>0.0000</td>
<td>0.5</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>36</td>
<td>36</td>
<td>37</td>
<td>0.0000</td>
<td>0.5</td>
<td>60</td>
<td>40</td>
</tr>
</tbody>
</table>

* Tie Lines, Substation Voltage = 12.66 kV

---

**Table 2. The result of applying algorithm**

<table>
<thead>
<tr>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branch Exchange</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>State</th>
<th>Base Case</th>
<th>Result (Best state)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lines switched out</td>
<td>33-34-35-36-37</td>
<td>9-7-14-31-37</td>
</tr>
<tr>
<td>Total kW Loss</td>
<td>212.817</td>
<td>124.036</td>
</tr>
<tr>
<td>Worst voltage (p.u)</td>
<td>0.899638</td>
<td>0.939557</td>
</tr>
</tbody>
</table>

---

**Table 3. Simulation result by arbitrary initial state**

<table>
<thead>
<tr>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branch Exchange</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>State</th>
<th>Base Case</th>
<th>Result (Best state)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>9-7-14-31-37</td>
</tr>
<tr>
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<td>124.036</td>
</tr>
<tr>
<td>Worst voltage (p.u)</td>
<td>0.899638</td>
<td>0.939557</td>
</tr>
</tbody>
</table>
4. Algorithm of Initial Operation Point Selection

As the result of Table 2 and 3, it is found that algorithm that can search for a high quality solution not only near the global optimal solution but also even in a random initial operation condition is needed. Therefore, in this part, wherever the state of the distribution power system is located, an algorithm that changes condition in order to access to an adjacent high quality solution is explained.

4.1 Optimal Solution

The result of Table 2 may be the global optimal solution in Fig. 6, and that of Table 3 is one of local optimal solutions.

As seen in Table 3, in case of a local optimal solution, base case should be transferred and its state should be changed near a high quality solution in order to obtain a high quality solution.

And a high quality solution is obtained by applying Branch Exchange Algorithm to the changed state.

Figure 7 shows that if the initial state of tie-line is placed near a high quality solution and is applied to existing reconfiguration algorithm, a desired high quality solution can be obtained.

The scale of distribution power system is considerably large, and there are a lot of loops included within it.

Under this condition, it is not easy to decide the operation point considering the inter-effect of loop. Accordingly, Eq. (5) is defined in order to calculate separately the loss minimization point at each loop

\[
\Delta P = Re \left\{ 2 \left( \sum_{i \in D} (E_m - E_n)_i \right) \right\} + R_{loop} \left| \sum_{i \in D} I_i \right|^2 \cdots \cdots (5)
\]

Here,

\(D\): The set of Node which are to be transferred to the line’s on/off

\[D = \{ \text{all lines} \}\]

In this equation, \(2 \left( \sum_{i \in D} (E_m - E_n)_i \right)\) means the amount of voltage drop up to Node 2 point that the structure within the system changes and \(I_i^2 (R_1 + R_2)\) means the value of load current square multiplied by the total of impedance up to node 2 that the structure within the system changes.

Enlarging it more, if it is examined in the looped system, it is shown as Fig. 9, the change of loss in this case is expressed as follows.

\[
P_{\text{loss}} = P_{\text{loss}}^0 - P_{\text{loss}}^i
\]

The change of loss depending on the change of distribution power system shown in Fig. 8 can be calculated loss change as follows.

\[
P_{\text{loss}}^i = 2I_1 (R_1 + R_2) + I_2^2 (R_1 + R_2)
\]

This Eq. (5) is the one that is supposed to decide the state of sectionalized switch at each loop so that random operation status of distribution power system can be located near a high quality solution.

4.2 Judgment of the Possibility of Applying the Distribution Power System Model

Before applying the distribution power system model, the verification is performed in order to apply Eq. (5) which was already defined.

The change of loss depending on the change of distribution power system shown in Fig. 8 can be calculated loss change as follows.

\[
\Delta P_1, \Delta P_2 \text{ expressed in Fig. 9 are the amount of loss change in the changing system. } \Delta P_1 \text{ indicates that the open point is moved to the next branch by one section and } \Delta P_1 + \Delta P_2 \text{ indicates that open point is moved to the next branch by more than two sections.}
\]

\[
\Delta P_1 : \text{The loss resulted from the change by exchanging the status of initial open point (Node 1-Node 1') and open point (Node 2-Node 1)}
\]

\[
\Delta P_2 : \text{The loss resulted from the change by exchanging the status of initial open point (Node 1-Node 1') and open point (Node 2-Node 1)}
\]

\[
\Delta P_1 = \{ \begin{array}{c} R_{1n} R_{2n} R_{1n} \\ R_{1n} R_{2n} R_{1n} \\ R_{1n} R_{2n} R_{1n} \end{array} \}
\]

\[
\Delta P_2 = \{ \begin{array}{c} R_{1n} R_{2n} R_{1n} \\ R_{1n} R_{2n} R_{1n} \\ R_{1n} R_{2n} R_{1n} \end{array} \}
\]
\( \Delta P_2 \): The loss resulted from the change by exchanging the status of open point (Node 2-Node 1) and open point (Node 3-Node 2).

If the loss change equation that was calculated by one feeder structure in Fig. 8 is applied to loop structure in Fig. 9 and \( \Delta P_1 \), \( \Delta P_2 \) are calculated as defined in Eq. (5), it can be applied to distribution power system of loop structure.

Changed load current is \( I_1 \) at \( \Delta P_1 \) in Fig. 9. Loss change equation calculated in Fig. 8 can be applied to the two sections from Feeder A to Node 2 and from feeder B to Node 1'.

In the section of from Node 2 to Node 1', \( \sum_{j=2}^{l1} R_j I_j \) is calculated as below.

\[
\Delta P_1 = \Delta P_{loss}^A = -2Re (I_j E_j^*) + |I_j|^2 R_{bus} (2, 2)
\]

\[
\Delta P_{loss}^B = 2Re (I_j E_j^*) + |I_j|^2 R_{bus} (1, 1)
\]

\[
\Delta P_{loss}^{pl} = |I_j|^2 R_0 - |I_j|^2 R_1
\]

Here, \( R_0 \) is Impedance of Branch in the initial open status.

\[
R_{bus} (2, 2) = \sum_{j=2}^{l1} R_j, \quad R_{bus} (1, 1) = \sum_{j=2}^{l1} R_j
\]

\[
E_2 = \sum_{j=2}^{l1} R_{bus} (2, j) I_j
\]

Therefore, \( \Delta P_1 \) can be indicated as below.

\[
\Delta P_1 = \Delta P_{loss}^A + \Delta P_{loss}^B + \Delta P_{loss}^{pl}
\]

\[
= 2Re [I_j (E_j^* - E_1^*)] + |I_j|^2 R_{loop}
\]

And \( \Delta P_2 \) can be also calculated by the same method.

\[
\Delta P_2 = 2Re [I_j (E_j^* - E_2^*)] + |I_j|^2 R_{loop}
\]

Here,

\[
E_1 = E_{i1} + \left( R_0 + \sum_{j=1}^{l1} R_j \right) I_1
\]

\[
E_2 = E_{i1} + \left( \sum_{j=2}^{l1} R_j \right) I_1 - R_1 I_1
\]

\( E_i \) means Voltage drop of each node at the first figure in Fig. 9 and \( E_i \) means Voltage drop of each node at the second figure in Fig. 9.

Therefore,

\[
\Delta P_{loss} = \Delta P_1 + \Delta P_2
\]

\[
= 2Re [I_j (E_j^* - E_1^*)] + R_{loop} |I_j|^2
\]

Using \( \Delta P_1 \), \( \Delta P_2 \) that were calculated before this equation, the loss that open point is changed from the first figure to the third figure in Fig. 9 by two sections is calculated within the system.

As it is shown in this equation, it is found that Eq. (5) can be applied in looped system.

Also, it is found that by the same method it is possible for Eq. (5) to be applied independently at each loop in distribution power system which includes many loops like Fig. 10.

Therefore, even though a number of loops are included in real distribution power system, the loss minimization point is calculated at each loop, through this process, the initial operation point can be calculated near a high quality solution.

4.3 Decision of the Loss Minimization Point in the Looped System As reactive power compensation is usually well performed in general distribution power system, the distribution power system is assumed as an ideal one. If so, Eq. (5) is defined as an real power factor which excludes the reactive power factor. In this case, Eq. (5) can be changed to Eq. (6).

\[
\Delta P_{loss} = 2 \left( \sum_{i \in D} I_i \right) (E_m - E_n) + R_{loop} \left( \sum_{i \in D} I_i \right)^2 \ldots \ldots \ldots (6)
\]

Equation (6) can be expressed as follows, \( I(x) \) means the current change factor depending on load transfer.

\[
\Delta P_{loss} = 2I(x) (E_m - E_n) + R_{loop} |I(x)|^2
\]
Fig. 11. Interrelation of each Branch current and $I(x_{opt})$ value

$$\Delta P_{loss} = R_{loop} \left[ (I(x))^2 + \frac{2(E_m - E_n) I(x)}{R_{loop}} \right]$$

$$= R_{loop} \left[ I(x) + \frac{(E_m - E_n)^2}{R_{loop}} \right] - \frac{(E_m - E_n)^2}{R_{loop}}$$

$$I(x_{opt}) = \frac{(E_m - E_n)^2}{R_{loop}}$$

$$\Delta P_{min} = -\frac{(E_m - E_n)^2}{R_{loop}}$$

$\Delta P_{loss}$ that is expressed as a quadratic of $I(x)$ has the loss minimum value when $I(x)$ is $I(x_{opt})$. Hence, it can be approached to the loss minimization point in loop by changing the state of branch that has the value of $I(x)$ which was calculated from the initial state and the state of currently opened branch at each loop.

Figure 11 shows this kind of example, and when calculated $I(x_{opt})$ value is near the current value of branch connecting the node of n-1 and n-2 ($\Delta_1 < \Delta_2$), currently opened m~n branch is closed and n-1~n-2 branch is opened as followed.

5. The Results of Applying the Distribution Power System Model

The algorithm explained above is applied to the distribution power system model in Table 1 and Fig. 5 and is examined.

Figure 5 is the state that was operated near a high quality solution as shown in the results of Table 3, and this state is changed into other random state. The algorithm of initial operation point is applied to this state, and the excellence is found by comparing solution of applied situation with that of unapplied one.

When the initial operation point algorithm is not applied, the result is shown in Table 3 (at the random operation state), and oppositely, the result is shown in Table 4.

As shown in Table 4, when the initial operation point algorithm is applied, the final solution is found as same as the solution from base case of Table 2.

Figure 12 is the simulation time shown in the paper already published which obtained the same solution as that of this paper by using Parallel Genetic Algorithm-Tabu Search Method (13).

In this paper, the simulation time is measured by increasing the numbers of processor from 1 to 8. In case of using one processor on the graph, approximately 5 seconds on simulation time is spent.

However, in this paper, just 0.2650 seconds of simulation time is spent to get the result of Table 4.

Comparing with the result from the existing papers that used one processor, results are shown to be improved by approximately 94.7% in the aspect of calculation time.

In case of using eight processors on the graph, in the existing papers approximately 0.6 seconds simulation time is spent. In this case, improved results are shown in algorithm suggested in this paper by approximately 55.84%.

After that, the accuracy is judged by applying this algorithm to the enlarged distribution power system model suggested in Fig. 13.

Voltage/Loss data of the initial state in Fig. 13 is shown in Table 5 (12).

The result of applying proposed algorithm to the initial
state is shown in Table 6, and it is compared with that of exiting proposed VSHDE (Variable scaling hybrid differential evolution) algorithms.

VSHDE algorithm is the one that is more improved than HDE (Hybrid Differential Evolution) algorithm. This mentioned HDE algorithm is a stochastic search and optimization method.

HDE algorithm is the one that the fittest of an offspring competes one to one with that of the corresponding parent. That is the difference between HDE and existing evolution algorithms. In the process one-to-one competition, it supplies fairly fast convergence speed.

VSHDE algorithm is based on HDE algorithm that has this above characteristics and it is an algorithm suggested for optimal reconfiguration of distribution power system. VSHDE algorithm has characteristics that use variable scaling factors in order to overcome the disadvantage of HDE algorithm that use random and fixed scaling factors. Hereby, VSHDE algorithm has the advantage that reduces the problem in selecting mutation operator in HDE algorithm.

As shown in Table 6, it is found that the result of Tie Switch at each algorithm is slightly different, consequently, the difference of reduction rate of voltage/loss is made. And it is found that it improves the loss when compared with existing algorithms. And it means that it approached to the global optimal solution more closely.

In addition, 0.3120 seconds of simulation time is spent to get the above results by using the algorithm suggested in this paper. Even though it is impossible to compare the simulation time with that of existing paper directly because it has not been mentioned in that, the results are considered as improved in the aspect of power loss.

6. Conclusion

This paper deals with the method of the optimal reconfiguration in distribution power system operation algorithms. Branch exchange algorithm has the disadvantage that induces the local optimal solution in the optimized stage. And combined solution method has the disadvantage that takes considerably long time to be calculated.

To complement these disadvantages, by adding the initial operation point algorithm to the branch exchange algorithm a new algorithm is suggested. As a result of applying this method, much faster and more improved solution in the aspect of power loss is obtained.

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References

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