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Locating minimum loss location for generators and loads in a 30 bus radial distribution system

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Abstract—This paper presents the 30 bus radial distribution system network. The main aim of this paper is to reduce the overall system losses in MW and MVAR and to improve the voltage profiles. The system uses optimal allocation of the generators as well as the loads in order to provide the efficient system. It uses the analysis of forward and backward sweep for having the load flow analysis and PSO that is Particle Swarm Optimization for selection of the parameters of new generators and new loads that is to be incorporated into the system network.

Index Terms—Distributed network, Forward Sweep, Backward Sweep, Losses, PSO, Voltage profiles

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1 INTRODUCTION

Losses and voltage profile are important performance parameters of radial distribution systems. In order to minimize these unwanted losses and to improve the voltage profile, the optimal allocation of generators as well as loads should be done. This will help in the reduction of overall system cost and increased reliability also.

2 FORWARD – BACKWARD SWEEP ALGORITHM

As the radial distribution system networks do not contain any slack bus or the reference bus, the conventional computations for load flow analysis cannot be performed in such networks. So, the forward and backward sweep analysis is performed for load flow analysis in the distribution system. The proposed radial distribution system network uses the forward and backward sweep analysis. The specialty of this forward and backward sweep analysis is that it comes up with load power flow problem. Forward/ backward sweep calculations are derivative free. This will reduce the Complexity for calculations of the system network.

In the forward sweep, the voltage node is fixed and is assumed to be known. This forward sweep uses the progressive sweeping by investigating the interconnections of the circuits as well as the loops present into the system.

It uses BIBC matrix that is bus injection to branch current matrix that provides the relationship between the bus injected current and branch currents.

In the backward sweep, the node is fixed and there is downstream sweeping by correcting the desired bus volt- ages.

3 ALGORITHM FOR FORWARD – BACKWARD SWEEP

Step-1: Start

Step- 2: It uses forward and backward sweeping for load flow analysis.

Step-4: It involves Particle Swarm Optimization for the selection of the parameters of generator as well as loads that should be incorporated into the system network in order to

Increase the efficiency of the network.

Step-5: It calculates the overall system losses along with the voltage profiles of the system network.

Step-6: Step-1 to step-5 is repeated to till the maximum iteration count is achieved.

Step-7: Display the calculated results along with the graph plotting.

Step-8 : Stop

4. FLOW CHART

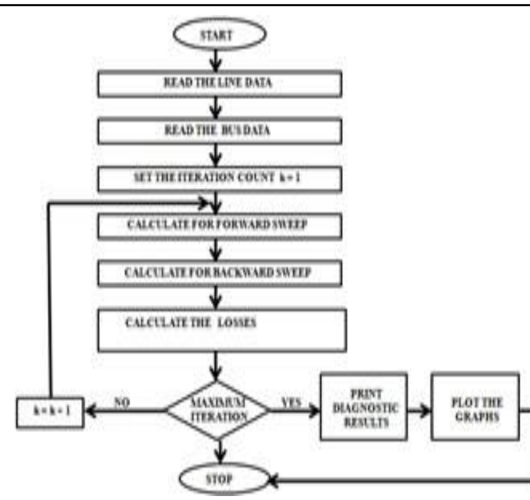

Fig. 1. Flow Chart for Forward– Backward Sweep

5 PSO TECHNIQUES

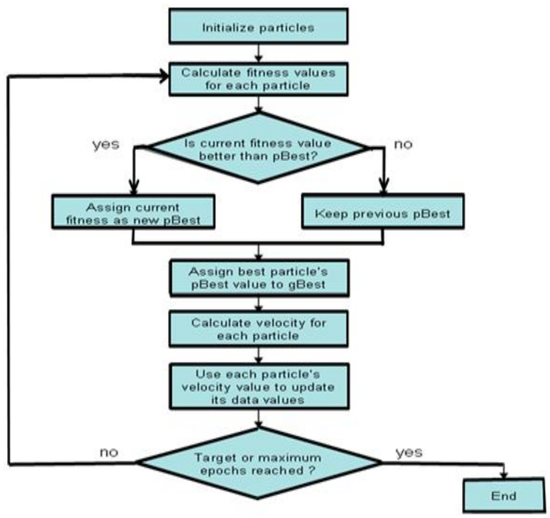

Fig. 2. Flow Chart for PSO Technique

6 SELECTION OF GX AND Lx

The selection of new generator and new load is done by using Particle Swarm Optimization technique. The system is initialized and it reads the line data as well as the bus data. The network uses the forward and backward sweep analysis for having the load flow. Particle Swarm Optimization involves the constants like maximum generation and initial population. The system randomly goes on for generating the initial population with various kinds of the positions and different dimensions by fixing up the iteration count. These entire processes will be carried out till the iteration count is achieved.

7 PROPOSED SYSTEM NETWORK

Proposed system involves 30 bus radial distribution system network. The simulation for 30 bus radial distribution system network is performed in matrix laboratory (MATLAB). In this case, 30 bus radial distribution system Simulink model is directed towards the matlab coding m file program. This program involves the calculations that are required for particle Swarm Optimization, forward and backward sweep analysis and for calling nn tool.

8 TRAINING OF THE SYSTEM NETWORK BY USING PSO

The neural networking tool consists of three layers that is input layer, hidden layer and output layer. Hidden layer may include more than one layer. Input layers include the input neurons and the hidden layers include hidden neurons. The crossover mutations take place between the input neurons that are present in the input layer and hidden neurons that are present in the hidden layer to produce the output neurons in the output layer. Such crossover mutations will help in finding out the perfect selection of the parameter for the generators and loads that are to be placed into the system.

The objective function for the proposed system is:

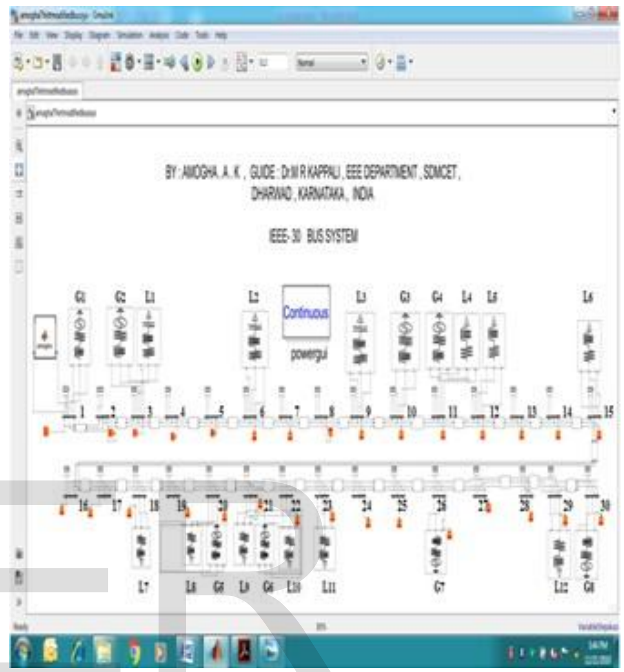

Fig. 3. Proposed system network with 30 bus radial distribution system in MATLAB Simulink

$P_{loss} = \sum_i^N |I_{bri}|^2 R_i$ and $Q_{loss} = \sum_i^N |I_{bri}|^2 X_i$

where, I_{bri} *is the current in branch* i, N is the total number of branches in the system, R_i *is the branch resistance* Program minimizes the loss ie. Min. P_{loss}. Q_{loss} is reactive power loss and X_i is reactance Fig.3 shows the circuit diagram of this proposed system.

9 RESULTS

Fig.4 shows the Bus "Number vs. Voltage" profiles (pu) for optimal allocation of generators and loads. The first graph is for the voltage profiles for the overall thirty bus system without the placement of the new generator 'Gx' and the new load 'Lx', the second graph shows the plotting of the voltage profile for the case of the generator placement, the third one shows the voltage profiles for the load placement into the system network and last one shows the voltage pro- file for the system where both the generator as well as the load is installed in the system.

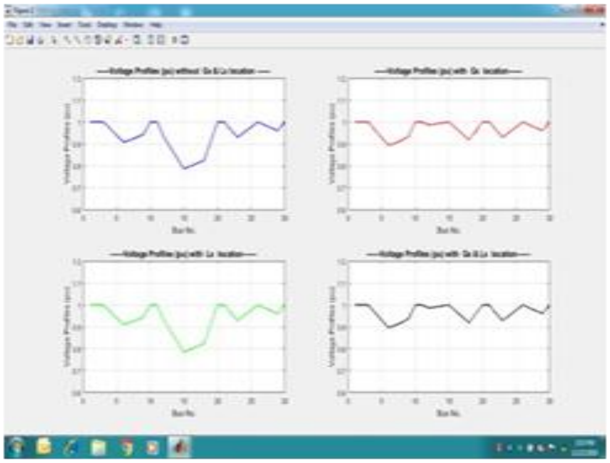

Fig. 4. Bus Number vs. Voltage Profiles (pu) for optimal allocation of generators and loads

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Total Overall System Losses : 34.6 MW , 108.7 MVAR
==================================
Gx & Lx Selection by using PSO i.e. "PARTICLE SWARM OPTIMIZATION METHOD"
=================================================
Gx & Lx :Gx : 35 MW & 80 MVAR , Lx : 10 MW & 0 MVAR
----------------------------------------------------
|Vlow|Gx at Vlow Bus No.| Vhigh |Lx at Vhigh Bus No.|System Losses(MW)|(MVAR)|
---------------------------------------------------------------------------------
0.7858        15            1          30                   30.6          96.1
---------------------------------------------------------------------------------
 |V(pu)|Location:Gx at Bus No.  | Total Overall System Losses(MW)    | (MVAR) |
---------------------------------------------------------------------------------
 0.7858      15                              33.6                       105.6
---------------------------------------------------------------------------------
 |V(pu)| Location: Lx  at  Bus No.|Total Overall System Losses(MW)    |(MVAR) |
---------------------------------------------------------------------------------
   1        30                              33.9                        106.6
---------------------------------------------------------------------------------
=================================================================================
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Fig. 5. Output obtained from MATLAB Command window

10 OBSERVATIONS

As we can observe from the outputs obtained in the MATLAB command window, the generator is placed at the bus where the voltage profile is low that is the generator is placed at bus number 15. The load is placed at the bus where the voltage profile is high that is the load is placed at bus number 30. This has led to the reduction of overall system losses.

11 CONCLUSIONS

The optimal placement of generator and load, separately or combined, at any bus can be done by considering the losses as the parameter of interest. If the losses are reduced at any bus by the placement of generator or load then that particular bus is the optimal location for generator or load that is to be placed in the distribution system network.

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