MLI TECHNIQUE FOR PLACEMENT AND SIZING OF DG FOR MINIMUM LINE LOSSES

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ABSTRACT

In distribution system, as shoot up requisition of distributed generations (DGs) has alter its custom from passive to active. Distributed generation can be desegregated into distribution systems to encounter the growing load demand. This paper suggests Maximum Loadability Index (MLI) technique for the optimal location and sizing of DG. The benefit of suggested technique is applied for single DG location and assessment on 6bus and IEEE 33-bus radial distribution systems. Load flow algorithm is applied for power flow calculations with abiding power load. Diminish of real power and reactive power, maximal of voltage profile and loadability of assessment system are reviewed as staging parameters. The benefit of the suggested technique is differentiate with subsist technique, the outcome exhibit that the suggested technique is worthwhile.

Key words: Distributed Generation, Placement, Maximum Loadability Index, Voltage Profile..

Cite this Article: G Sasi Kumar, S Sarat Kumar and S V Jayaram Kumar, MLI Technique for Placement and Sizing of DG for Minimum Line Losses. *International Journal of Electrical Engineering and Technology*, 11(4), 2020, pp. 266-274.
<https://iaeme.com/Home/issue/IJEET?Volume=11&Issue=4>

1. INTRODUCTION

Today the In present days, the involvement of distributed generation is increasing. This increased distributed generation causes over voltages problem in distribution system. In order to avoid this proper placing of DG and sizing of DG is very important. In [1], DG was used just for the reduction of power system losses. In this paper the location of distributed generation is based on the reduction of power losses. Wang et al., proposed an analytical approach for the placement of distributed generation. In this paper DG is optimally located on radial distributed system based on analytical approach [2].

Rahman et al., proposed a new method for the placement of embedded generators, in addition to placement the sizing of DG also evaluated using this new method [3]. Nadri proposed dynamic approach for the planning of distributed system in the presence of distributed generation [4]. Here, system planning is done considering the distributed generation and its effects are explained. Acharya et al., proposed a new analytical approach, In which the optimal allocation of DG in primary distribution network is through this approach [5].

Alsaadi and Gholami was proposed an effective approach for distribution system, in this paper a new power flow solution method was proposed in the presence of distributed generation [6]. In [7], Backward/Forward sweep algorithm was proposed for power flow calculation in radial distribution systems. Different authors proposed different methods like sensitivity analysis, V-Index, analytical approach and numerous optimization techniques for optimal location and sizing of DG's [8-9]. In the contemporary condition, evolutionary programming is used for the optimal location and sizing of DG's. Genetic algorithm, particle swarm optimization, Tabu search, artificial immune system and many other evolutionary programs were proposed by different authors for optimal allocation of DG's [10-11]. All these methods were incompetent to guarantee the solution, because attain solution may be local optimal or global optimal.

This paper implements a new method for placement of DG and sizing based on the line maximum loadability index. Earlier Model analysis and continuous power flow method are used for obtaining the most critical bus in the distribution network which could lead to instability of the system when the loads are increased. The new method is also identified the critical bus for the DG placement. The sizing of DG is estimated considering the minimum losses by using search algorithm. Finally finding the placement and sizing of DG using the new method is simpler and requires less time as compared with existing algorithms.

The sections of this paper are organized as follows : in Section 2, Mathematical modeling of Maximum Loadability Index of a equivalent of electrical distribution line (suppose k – m line). Section 3 presents implementation of algorithm based on MLI. Effectiveness of proposed algorithm tested on IEEE -6 bus and IEEE – 33 bus RDS test system presented in Section 4. The results are discussed in detail and compared with existing algorithm.

2. MATHEMATICAL MODELING OF MAXIMUM LOADABILITY INDEX

Fig.1 shows the equivalent circuit of a simple line with sending and receiving ends.

Figure 1 Equivalent line of electric distribution network.

The formulation of multi objective function (MOF) consists of two terms, first one is the power loss and second one is switching operations.

Equation 1 represents the expression for the calculation of maximum loadability index (MLI) [12] .

$$MLI = \frac{V_m^2 \left[-(r_{mn}P_{mn} + x_{ij}Q_{ij}) + \sqrt{(r_{mn}^2 + x_{mn}^2)(P_{mn}^2 + Q_{mn}^2)} \right]}{2(x_{ij}P_{mn} - r_{mn}Q_{mn}) * (x_{ij}P_{mn} - r_{mn}Q_{mn})} \quad (1)$$

Where R & X indicates resistance and reactance of the line, V & δ indicates voltage magnitude and angles at nodes respectively, P & Q are the real and reactive powers of the line respectively. Suffixes 'm' and 'n' are the sending end node and receiving end nodes respectively.

3. PROPOSED METHOD (MAXIMUM LOADABILITY INDEX METHOD)

The following steps are used for the implementation of proposed method:

Step 1: Read the system data

Step 2: Run Backward/forward algorithm and calculate power flows and voltages

Step 3: from step 2, determine MLI for all the lines in the system using Equation 1

Step 4: Identify the line which is having minimum Loadability index

Step 5: set the optimal Location of DG as the ending bus of the line which is having minimum MLI

Step 6: Set DG output to zero initially

Step 7: Check the DG real power Constraints, if satisfied then go to next step otherwise go to step 11

Step 8: Run Backward/forward algorithm and calculate power flows and voltages with DG

Step 9: Save X_{iter} for each DG real power

Step 10: if X_{iter} is less than or equal to X_{iter-1} then go to step 14 otherwise step 12

Step 11: DG values are taken from the constraints

Step 12: DG values set as optimum

Step 13: check voltage limits, if satisfied go to step 16 otherwise go to step 14

Step 13: find the DG real power based on voltage condition and then go to step

Step 14: update real power of DG and then repeat steps 7, 8 and 9

Step 15: determine the error using the following formula: error=step11-step13-step 9 and neglect unsuitable vales go to step 16

Step 16: print optimal size and location of DG

Step 17: stop

4. TEST SYSTEM

The proposed controllers are applied on two types of test systems:

Case 1: 6 bus system

Case 2: IEEE 33 bus system

5. RESULTS & DISCUSSION

5.1. Case 1

In case 1, the proposed method is tested on 6 bus system and is shown in fig.2

Figure 2 6 Bus Radial System.

Table 1 Optimal location of DG with proposed method

Method	Bus No
MLI	3

Table 2 Power losses with respect to optimal size and location using proposed method

Method	APL (KW)	RPL (KVAR)	Apparent Power (KVA)	DG Size (KW)	DG Location
proposedMLI	0.2607	0.147	0.2993	344	3

Table 3 Power losses and minimum voltages without DG and with DG using proposed method

Power Loss	Before DG	After DG	% Decrease	Parameter	Before DG	After DG
Active Power Loss (KW)	0.6961	0.2607	67.8	Vmin (p.u)	0.997	0.999
Reactive Power Loss (KVAR)	0.362	0.147	66.5	VSI min (p.u)	0.989	0.996
Apparent Power Loss (KVA)	0.7838	0.2993	67.51			

Table.1 shows the optimal locations of DG using proposed method (MLI).

Table.2 shows the real, reactive and apparent power losses with proposed method MLI. Fig.3 indicates the variation of power losses with respect to DG size using proposed method.

Figure 3 Active power losses with respect to DG size with proposed method.

Table 3 indicating how the active power, reactive and apparent power losses are decreasing with the proposed method. Minimum voltage and voltage stability index minimum values are also shown in table.3.

From table 3, it is clear that the proposed method decreases active power by 67.8%, reactive power by 66.5% and apparent power by 67.51%.

From this discussion, it is clear that the proposed method is effectively decreasing power losses and increasing the voltages.

5.2. Case 2

Table 4 Optimal location of DG with different Existing methods

Method	Bus No
Analytical method	6
Proposed MLI	6

Table 5 Power losses with respect to optimal size and location of DG using different existing methods with proposed method

Method	APL (KW)	RPL (KVAR)	Apparent Power (KVA)	DG Size (KW)	DG Location
Base Case	202.34	134.9	243.21	-	-
Analytical method [5]	111.1	-	-	2490	6
Proposed MLI	104.19	74.81	128.27	2425	6

Figure 4 IEEE 33 bus radial system.

Table 6 Power losses and minimum voltages without DG and with DG using proposed method

Power Loss	Before DG	After DG	% Decrease
Active Power Loss (KW)	202.34	104.01	48.6
Reactive Power Loss (KVAR)	134.9	74.81	44.62
Apparent Power Loss (KVA)	243.19	128.05	47.1

Table.4 shows the optimal locations of DG using Analytical method, and proposed method (MLI).

Table.5 shows how the real, reactive and apparent power losses are changing with respect to Analytical method , and proposed MLI. Fig.3 indicates the variation of power losses with respect to DG size using proposed method.

From table 6, it is clear that the proposed method decreases active power by 48.6%, reactive power by 44.62% and apparent power by 47.1%. and other methods reactive and apparent losses are not discussed.

The proposed method results compared with analytical method, from this real power losses reduced by 7 KW, size of DG is reduced by 0.11MW, minimum voltage is improved by 0.27 p.u and 3.4% improvement in the loss reduction.

From this discussion, it is clear that the proposed method is effectively decreasing power losses and increasing the voltages.

Figure 5 Voltage profile of IEEE 33 bus system.

Fig.5 shows the voltage profile of all the buses of IEEE 33 bus system, from this minimum voltage is improving using proposed method.

Active power loss, Reactive power loss and apparent power loss comparison is shown in fig.6. From this figure also, it can concluded that the proposed method is effective.

Table.8 indicates the power flows in the respective lines with and without DG considering MLI concept. Fig.8 shows the comparison, from this each line loading capability is increased with DG

Figure 6 Power loss comparison without and with DG.

Figure 7 Power loss comparison without and with DG.

Table 7 maximum Loadability index with and without DG

Line Num	MLI with DG	MLI
1	172.3629	90.5027
2	40.2401	19.1683
3	93.6783	34.5497
4	98.9624	34.4941
5	33.8381	13.7307
6	60.5811	56.1957
7	53.6314	49.7219
8	41.0622	38.0398
9	43.9639	40.6868
10	294.1269	271.945
11	168.6891	155.945
12	40.9072	37.8074
13	103.1655	95.2509
14	169.5403	156.474
15	179.0419	165.204
16	113.1187	104.352
17	402.0365	370.749
18	417.9179	385.355
19	68.3995	68.1871
20	335.7889	334.739
21	364.6503	363.508
22	70.3875	70.1668
23	37.2985	36.5568
24	73.9895	72.4982
25	131.0995	128.439
26	99.3756	92.1539
27	22.7979	21.1325
28	30.9728	28.6576
29	67.2286	62.1195
30	58.7839	54.2845
31	261.683	241.485
32	838.0165	773.214

6. CONCLUSION

In this paper, Maximum loadability index method is proposed for optimal location and sizing of DG. This MLI method is implemented on IEEE 6 bus system and IEEE 33 Bus systems. The performance of MLI is compared with previous existing methods and concluded that MLI method enhancing the loading capabilities of the lines, voltages at buses, decreasing the real, reactive and apparent power losses effectively.

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