I J C T A, 9(32), 2016, pp. 175-181 ISSN: 0974-5572

Smart Method for Minimising Transmission Line Losses

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ABSTRACT

Power transmission efficiency can be improved by minimising the transmission line losses. A smart selection of initial voltages as input to load to flow analysis is proposed to this paper in the first stage and graph theory is applied to the second stage to the IEEE 30 bus system and the losses are reduced to7.449 MW and 0.287Mvar.

Keywords: Minimum transmission loss, smart method, graph theory.

1. INTRODUCTION

Graph theory for power loss minimization was done. The transmission line contributing the highest transmission loss is deleted. By using the graph theory, both active and reactive power losses are reduced. Since the current in the transmission line depends on the voltage difference between the buses, minimum deviation of voltages at load bus is required. Three thousand unique solutions to the gradual decrease in active power loss are done; the stopping criteria for repeated genetic algorithm are not clearly specified. It means that there does always a probability of better solution to the minimum power transmission loss. Using trial and error method we can set the generator bus voltages at one value and load bus voltages at another value. The new method of assigning generator and load bus voltages using the trial method is proposed to this paper and is explained in the following section for minimization of both the active power loss and reactive power loss.

2. METHODOLOGY

Initially the slack bus, generator bus and load bus voltages are assigned random values within the limits of generator voltage constraint and load bus voltage constraint between 1.05 and 0.95 per unit. The MATLAB POWER SYSTEM TOOL BOX developed by Hadi Sadat and the MATPOWER developed by Ray Zimmerman is used for the case study on the IEEE 30 bus system. Initially the generator and slack bus voltages are assigned to 1.05 per unit. All the transformer tap settings are set equal to 1.0 per unit. All load

Table 1
Generator minimum Mvar and maximum Mvar

Generator bus no.	*minimum Mvar*	*maximum Mvar*
2	-20	60
5	-15	60
8	-15	50
11	-10	40
13	-15	45

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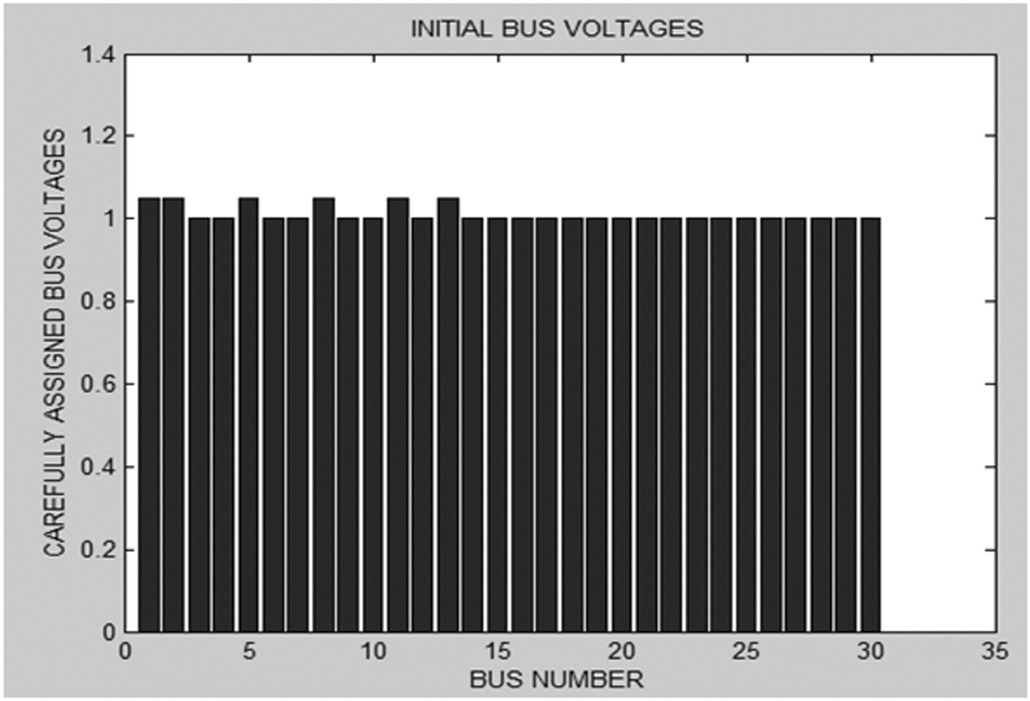


Figure 1: The initial bus voltage

bus voltages are assigned to 1.0 per unit. Generator minimum Mvar and maximum Mvar are set initial values given in the Table.1 below. All the bus voltage angle is set equal to 0.

Newton- Raphson method is applied to obtain load flow solution

The below figure 2a shows that load bus voltages are within the limits of 1.05 and 0.95 p.u.

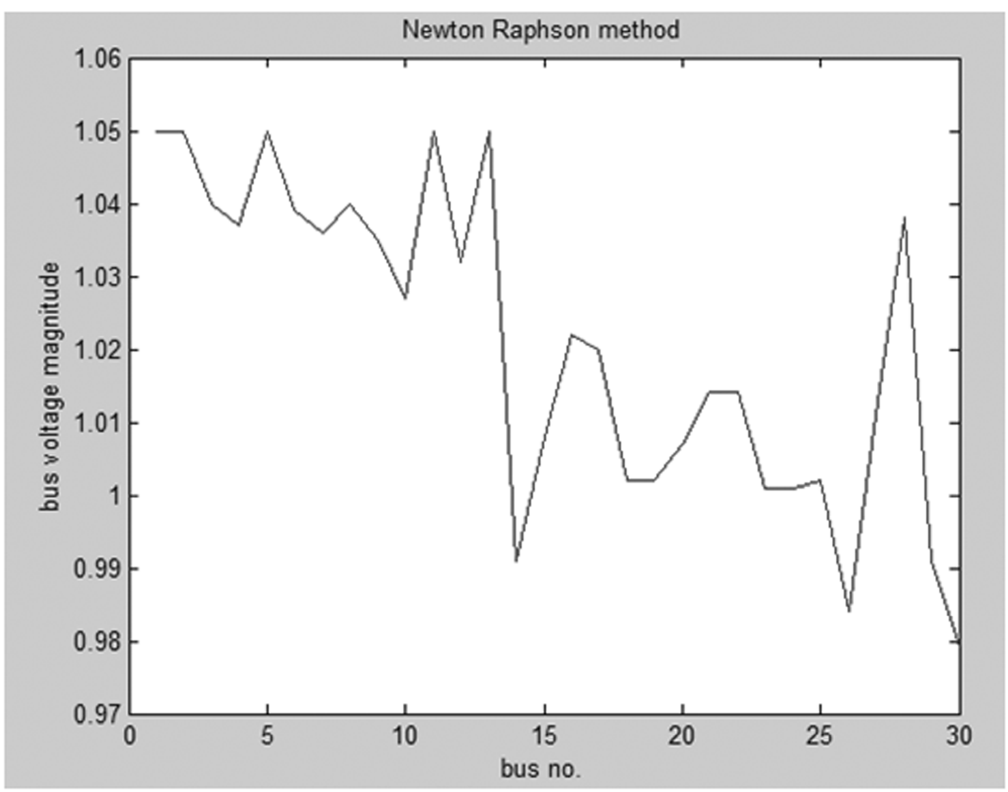
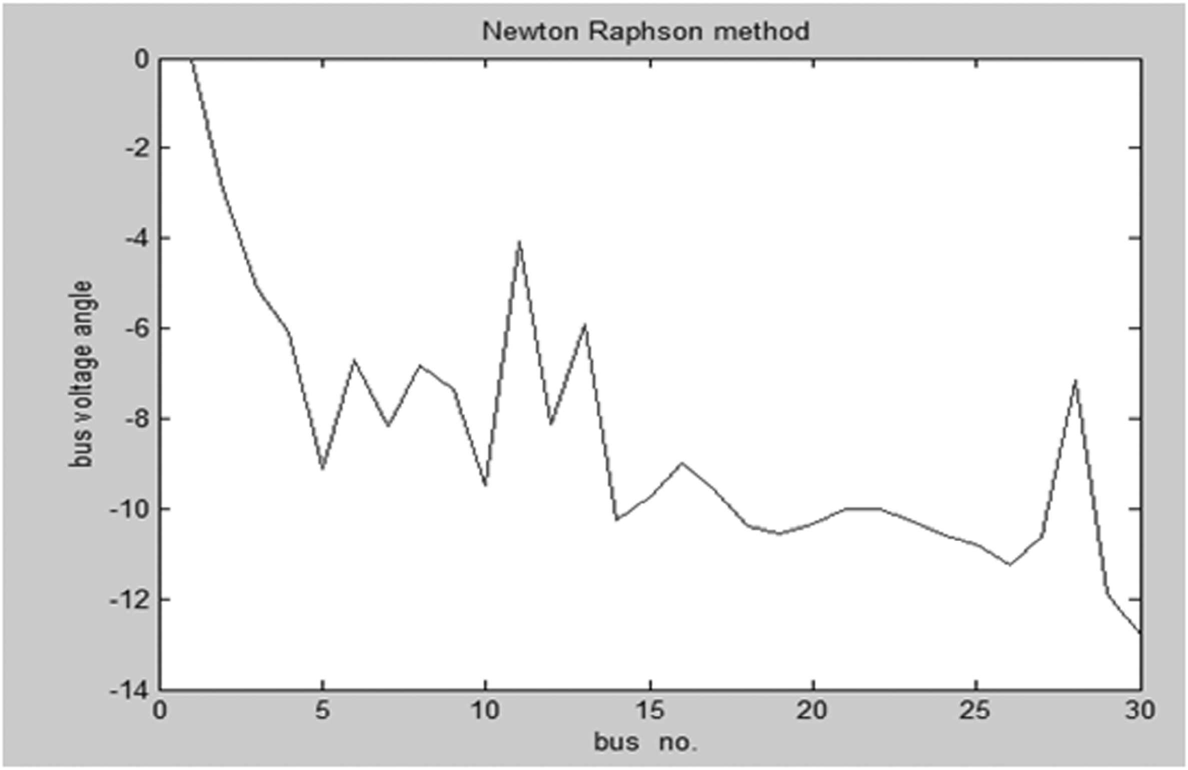


Figure 2a: Initial Load Flow Solution Using Smart Method.

The below figure 2b shows that all the bus voltage angle is less than -14 degrees.



The initial line flow using smart method is given below

—Line—from	*to*	*Power at bus & line flow*			*—Line loss— Transformer tap*	
		MW	*Mvar*	*MVA*	*MW*	*Mvar*
1		140.493	-37.005	145.284		
	2	89.391	-30.227	94.364	1.522	-1.264
	3	51.101	-6.778	51.549	1.079	-0.035
2		8.300	9.425	12.559		
	1	–87.870	28.963	92.520	1.522	-1.264
	5	57.133	-12.699	58.527	1.444	1.457
	6	39.037	-6.839	39.632	0.815	-1.606
3		-2.400	-1.200	2.683		
	1	-50.022	6.743	50.475	1.079	-0.035
	4	47.622	-7.943	48.280	0.284	-0.092
4		-7.600	-1.600	7.767		
	3	-47.339	7.851	47.985	0.284	-0.092
	6	24.823	-11.828	27.497	0.082	-0.683
	12	14.915	2.376	15.103	0.000	0.543
5		-64.200	29.364	70.597		
	2	-55.689	14.155	57.460	1.444	1.457
	7	-8.511	15.208	17.428	0.142	-1.862
6		0.000	0.000	0.000		
	2	-38.222	5.233	38.579	0.815	-1.606
	4	-24.741	11.145	27.135	0.082	-0.683

(*contd...*)

(*Table contd...*)

—Line—from	to	Power at bus & line flow			—Line loss—	Transformer tap
		MW	Mvar	MVA	MW	Mvar
	7	31.711	-7.205	32.520	0.259	-1.035
	8	3.200	-4.705	5.690	0.003	-0.961
	9	5.801	1.926	6.113	0.000	0.072
	10	9.260	2.492	9.589	0.000	0.474
	28	12.991	-8.887	15.739	0.027	-13.915
7		-22.800	-10.900	25.272		
	5	8.653	-17.070	19.138	0.142	-1.862
	6	-31.453	6.170	32.052	0.259	-1.035
8		0.000	1.640	1.640		
	6	-3.197	3.744	4.923	0.003	-0.961
	28	3.197	-2.104	3.827	0.006	-4.600
9		0.000	0.000	0.000		
	6	-5.801	-1.854	6.091	0.000	0.072
	11	-30.000	-6.666	30.732	0.000	1.834
	10	35.801	8.520	36.801	0.000	1.391
10		-5.800	17.000	17.962		
	6	-9.260	-2.018	9.477	0.000	0.474
	9	-35.801	-7.129	36.504	0.000	1.391
	20	9.781	5.163	11.061	0.109	0.243
	17	4.144	6.739	7.911	0.019	0.050
	21	16.955	9.797	19.582	0.127	0.273
	22	8.381	4.447	9.488	0.062	0.128
11		30.000	8.500	31.181		
	9	30.000	8.500	31.181	0.000	1.834
12		-11.200	-7.500	13.479		
	4	-14.915	-1.833	15.027	0.000	0.543
	13	-30.000	-12.895	32.654	0.000	1.402
	15	25.256	6.136	25.991	0.420	0.828
	16	8.459	1.092	8.529	0.065	0.136
13		30.000	14.298	33.233		
	12	30.000	14.298	33.233	0.000	1.402
14		-6.200	-1.600	6.403		
	15	-6.200	-1.600	6.403	0.092	0.083
15		-8.200	-2.500	8.573		
	12	-24.836	-5.309	25.397	0.420	0.828
	14	6.292	1.683	6.514	0.092	0.083
	18	5.285	0.195	5.288	0.030	0.060
	23	5.059	0.930	5.144	0.026	0.053
16		-3.500	-1.800	3.936		
	12	-8.395	-0.956	8.449	0.065	0.136
	17	4.895	-0.844	4.967	0.019	0.045

(*contd...*)

(*Table contd...*)

—Line—from	to	Power at bus & line flow MW	Mvar	MVA	—Line loss— MW	Transformer tap Mvar
17		-9.000	-5.800	10.707		
	16	-4.875	0.889	4.955	0.019	0.045
	10	-4.125	-6.689	7.859	0.019	0.050
18		-3.200	-0.900	3.324		
	15	-5.255	-0.135	5.257	0.030	0.060
	19	2.055	-0.765	2.193	0.003	0.006
19		-9.500	-3.400	10.090		
	18	-2.052	0.771	2.192	0.003	0.006
	20	-7.448	-4.171	8.537	0.025	0.049
20		-2.200	-0.700	2.309		
	19	7.473	4.221	8.582	0.025	0.049
	10	-9.673	-4.921	10.852	0.109	0.243
21		-17.500	-11.200	20.777		
	10	-16.828	-9.525	19.337	0.127	0.273
	22	-0.672	-1.675	1.805	0.000	0.001
22		0.000	0.000	0.000		
	10	-8.319	-4.319	9.373	0.062	0.128
	21	0.672	1.676	1.806	0.000	0.001
	24	7.646	2.643	8.091	0.073	0.114
23		-3.200	-1.600	3.578		
	15	-5.033	-0.878	5.109	0.026	0.053
	24	1.833	-0.722	1.970	0.005	0.010
24		-8.700	-2.400	9.025		
	22	-7.573	-2.530	7.985	0.073	0.114
	23	-1.828	0.733	1.970	0.005	0.010
	25	0.701	-0.603	0.925	0.002	0.003
25		0.000	0.000	0.000		
	24	-0.700	0.606	0.926	0.002	0.003
	26	3.546	2.369	4.265	0.046	0.069
	27	-2.846	-2.975	4.117	0.018	0.035
26		-3.500	-2.300	4.188		
	25	-3.500	-2.300	4.188	0.046	0.069
27		0.000	0.000	0.000		
	25	2.865	3.010	4.156	0.018	0.035
	28	-16.154	-6.356	17.360	0.000	1.168
	29	6.193	1.675	6.416	0.089	0.167
	30	7.096	1.671	7.290	0.167	0.313
28		0.000	0.000	0.000		
	27	16.154	7.524	17.821	0.000	1.168
	8	-3.191	-2.495	4.051	0.006	-4.600
	6	-12.964	-5.029	13.905	0.027	-13.915

(*contd...*)

(*Table contd...*)

—Line—from to		Power at bus & line flow			—Line loss— Transformer tap	
		MW	Mvar	MVA	MW	Mvar
29		-2.400	-0.900	2.563		
	27	-6.105	-1.508	6.288	0.089	0.167
	30	3.705	0.608	3.754	0.034	0.065
30		-10.600	-1.900	10.769		
	27	-6.930	-1.357	7.061	0.167 0.313	
	29	-3.670	-0.543	3.710	0.034 0.065	
		Total loss			7.093	-14.979

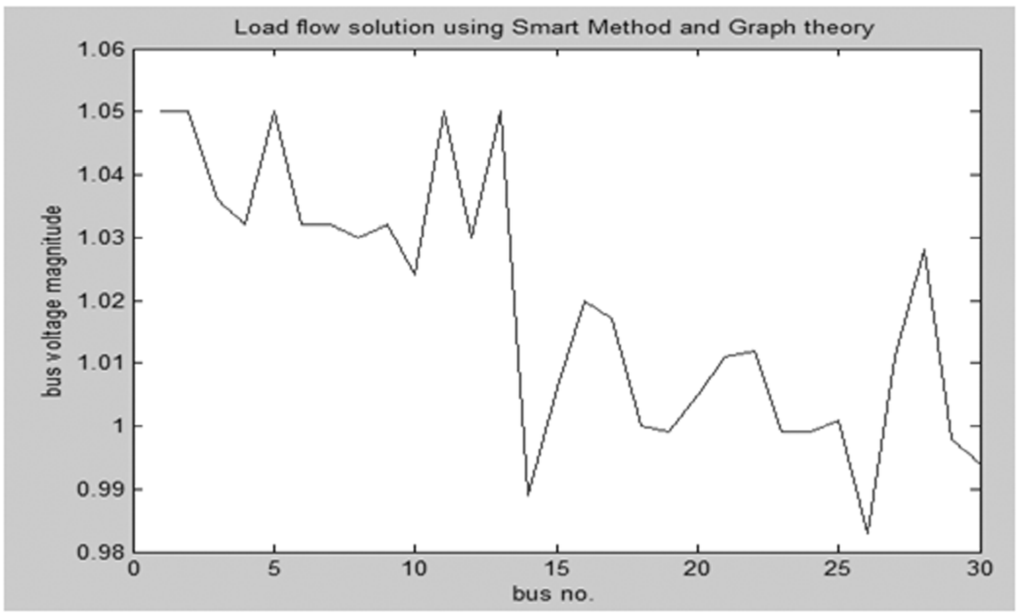


Figure 3a: The load flow solution with smart method and graph theory.

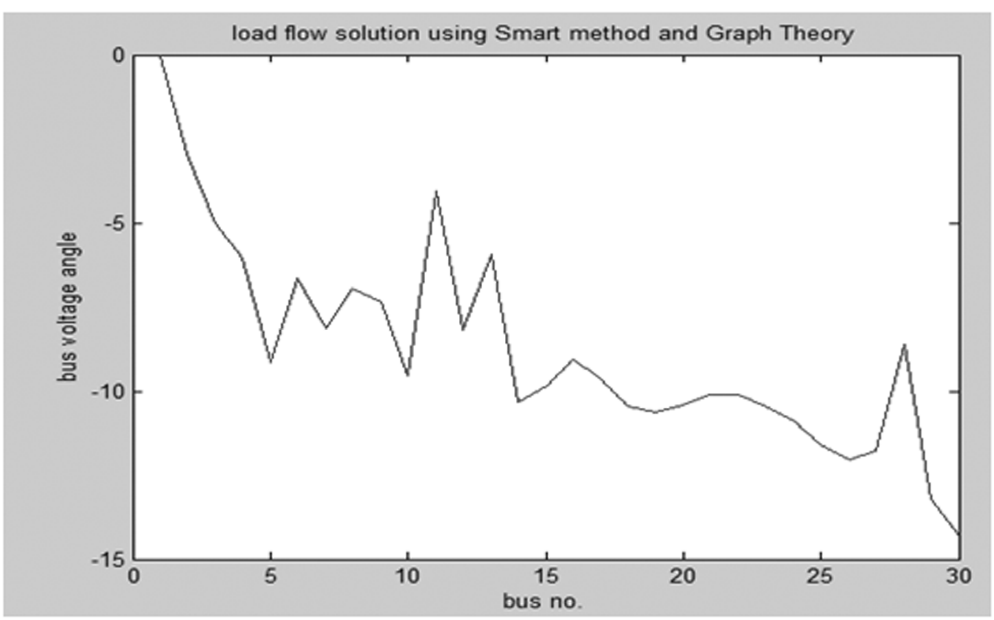


Figure 3b: The load flow solution with smart method and graph theory.

The line 28 to 6 has the maximum loss and is deleted from the line data, then load to flow analysis is done and the losses are reduced to 7.336 MW and -0.190 Mvar. The load flow results are given in below figure 3a and 3b.

Table 2
Final Generator minimum Mvar and maximum Mvar, Capacitor Mvar

Bus no.	*minimum Mvar*	*maximum Mvar*	*Capacitor Mvar*
2	-20	50	0
5	-15	40	12.124
8	-15	40	2.0
11	-10	24	0
13	-15	24	0
10	0	0	19
24	0	0	4.3
28	0	0	6
30	0	0	4

For the load flow solution using smart method and graph theory the 5th and 8th generator maximum Mvar were exceeding their upper limits. The 30th bus voltage was nearing to 0.955 per unit. Table2. gives the combination for compensating the constraints.

3. CONCLUSION

Carefully selected initial value of bus voltages significantly reduces the active power loss and reactive power loss.

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