$$v(k) = v(k-1) - I_{branch}(k-1) * Z_{branch}(k-1) \quad (3)$$

Where N=number of nodes, nb=number of branches.
Finally from the branch currents calculate real and reactive power losses using below given equation (4).
Total real power loss is given by

$$P_{totalloss} = \sum_{k=1}^{nb} |I_{branch}(k)|^2 \times R_{branch}(k) \quad (4)$$

Total reactive power loss is given by

$$Q_{totalloss} = \sum_{k=1}^{nb} |I_{branch}(k)|^2 \times X_{branch}(k) \quad (5)$$

3.1. Algorithm Ffor Load Flow Solution

1. Read line and load data
2. Arrange voltage value as 1 per unit for all nodes.
3. Compute load currents using equation (1)
4. Compute apparent power as $S_{old} = V_k * I_{load}$.
   Where V_k is node voltage
5. Compute branch currents using backward Propagation from equation (2).
6. Update node voltages using forward propagation from equation (3).
7. Compute apparent power at each node using
   $S_{new} = V_{knew} * I_{load}$
   Where V_{knew} is updated new voltage of kthnode.
8. Compute Sdel= max(|Snew-Sold|)
9. If the difference of apparent power magnitude is less than 0.0001, stop the iteration.
10. Otherwise, go to step (3)
11. Compute branch power losses, total system losses using equations (4) and (5).

3.2 Flow chart for load flow solution

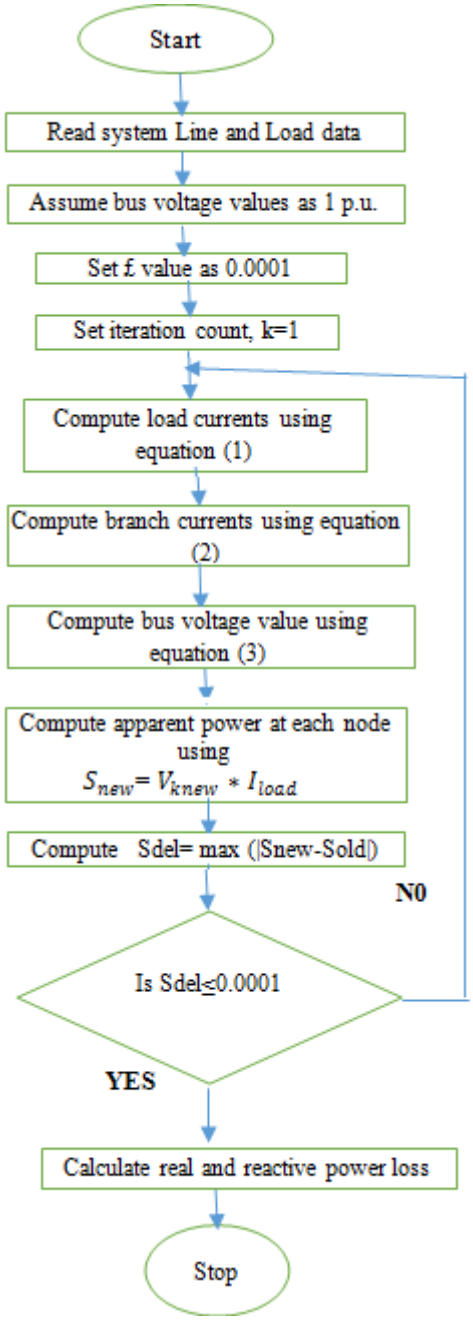

Figure 2: Flow chart for load flows

4. Results analysis

IEEE-10 bus and IEEE-12 bus radial distribution systems are considered to evaluate the proposed method [7-8].

a) IEEE-10 bus radial distribution system

The BASEMVA and BASEKV for this system are 100 and 23.

Table 1: The branch results of 10-bus radial distribution system.

Branch number	Branch currents (p.u.)	Branch loss (p.u.)
1	0.1315	0.0005
2	0.1130	0.0000
3	0.1032	0.0018
4	0.0848	0.0011
5	0.0689	0.0019
6	0.0518	0.0005
7	0.0433	0.0008
8	0.0304	0.0009
9	0.0192	0.0004

Table 2: The bus results of 10-bus radial distribution system

Bus number	Bus currents (p.u.)	Bus voltages (p.u.)
1	0	1.0000
2	0.0185	0.9929
3	0.0098	0.9874
4	0.0184	0.9634
5	0.0159	0.9480
6	0.0171	0.9172
7	0.0085	0.9072
8	0.0128	0.8889
9	0.0112	0.8587
10	0.0192	0.8375

The total real power loss = 783.8064 kW.
The total reactive power loss = 1.0369e+03 kVAr.
The minimum voltage value in p.u. =0.8375
The bus number having minimum voltage = 10.

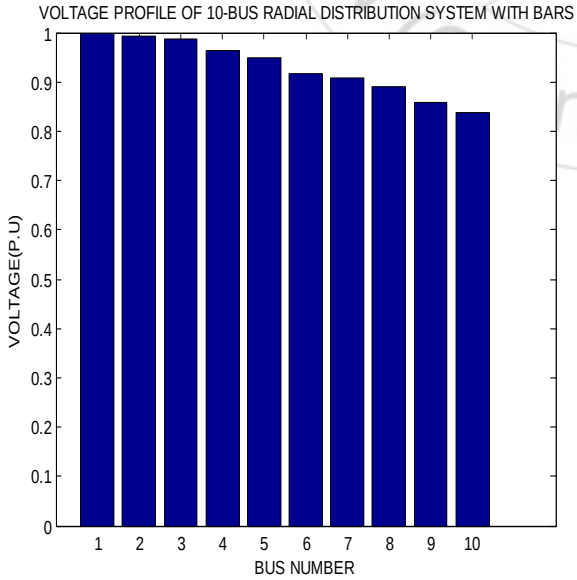

Figure 3: Voltage profile of 10-bus radial distribution system with bars

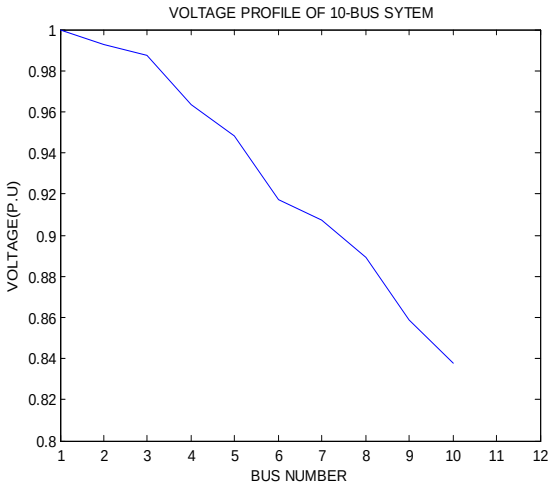

Figure 4: Voltage profile of 10-bus radial distribution system

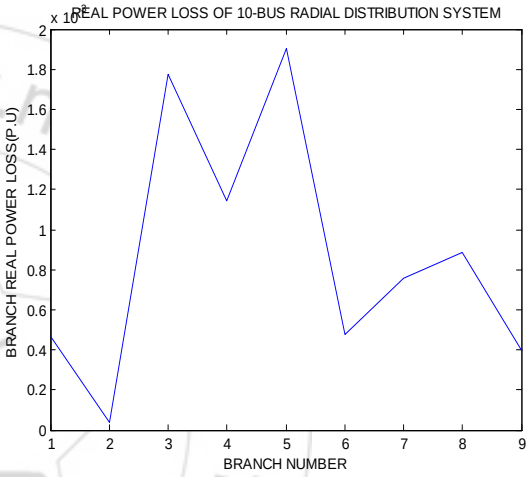

Figure 5: Real power loss of 10-bus radial distribution system

b) IEEE-12 bus Radial Distribution System

The BASEMVA and BASEKV for this system are 10 and 11. The voltage mismatch based convergence criteria is used.

Table 3: The branch results of 12-bus radial distribution system.

Branch number	Branch currents (p.u.)	Branch real power loss (p.u.)*10^-3
1	0.0456	0.3417
2	0.0395	0.2747
3	0.0355	0.3980
4	0.0298	0.4220
5	0.0267	0.1148
6	0.0246	0.0906
7	0.0188	0.2277
8	0.0140	0.1573
9	0.0097	0.0368
10	0.0059	0.0071
11	0.0016	0.0005

Table 4: The bus results of 12-bus radial distribution system.

Bus number	Bus(load) currents (p.u.)	Bus voltages (p.u.)
1	0.0615	1.0000
2	0.0615	0.9943
3	0.0530	0.9890
4	0.0479	0.9806
5	0.0400	0.9698
6	0.0357	0.9665
7	0.0331	0.9638
8	0.0250	0.9553
9	0.0184	0.9473
10	0.0124	0.9445
11	0.0075	0.9436
12	0.0022	0.9435

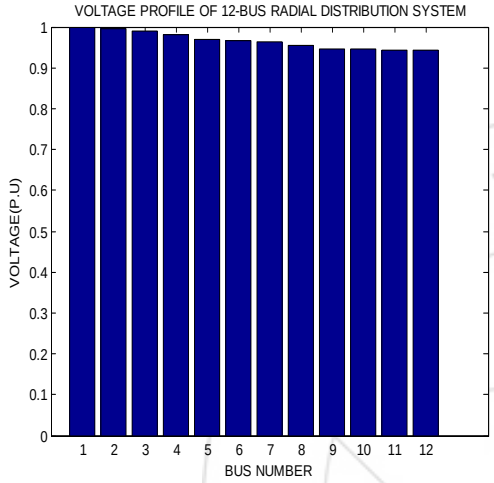

Figure 6: Voltage profile of 12-bus radial distribution system with bars

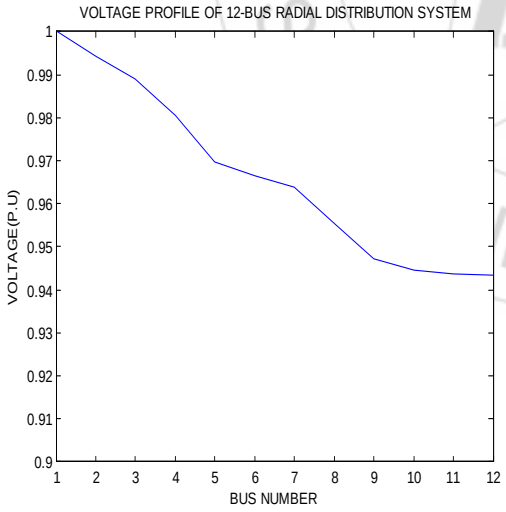

Figure 7: Voltage profile of 12-bus radial distribution system

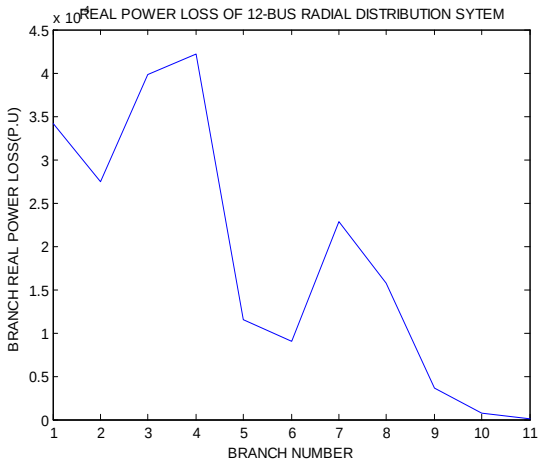

Figure 7: Real power loss of 12-bus radial distribution system

The total real power loss =20.7120 kW.
The total reactive power loss = 8.0405 kVAr.
The minimum voltage value in p.u.= 0.9435.
The bus number having minimum voltage = 12.

5. Conclusion

In this paper, load flows are done with the help of apparent power mismatch. The basic thing used here is backward and forward method. To analyze the effectiveness of this method two test systems namely 10-bus and 12-bus radial distribution have taken. This methods gives simple equations for radial distribution system. The radial distribution systems taken here are having only radial structure. They do not have laterals and sub laterals.

References:

[1] Baran M.E. and Wu F.F., "Network Reconfiguration in Distribution Systems for Loss Reduction and Load Balancing," IEEE Trans. Power Delivery, vol.4, no.2, pp. 1401-1407, 1989.
[2] D.Shirmohamadi, H.W.Hong, A. Semlyen, and G.X. Luo, "A compensation based power flow method for weakly meshed distribution and Vol, 3, no.2, pp. 753-762, May 1998.
[3] W.H. Kersting, "A method to the design and operation of distribution systems", IEEE Trans., PAS-103, pp. 1945-1952, 1984.
[4] C.G. Renatotransmission networks," IEEE Trans. Power Syst., "New method for the analysis of distribution networks," IEEE Trans. PWRD-5, (1), pp. 9-13, 1990.
[5] GB Jasmon and L.H.C.C. Lee, "Distribution network reduction for voltage stability analysis and load flow calculations," International Journal of Electrical Power and Energy systems, vol.13, no.1, pp. 9-13, 1991.
[6] S.K. Goswami, and S.K. Basu, "Direct solution of distribution systems," IEE Proc. C., 188, (1), pp. 78-88, 1991.
[7] D. Das, H.S. Nagi, and D.P. Kothari, "Novel method for solving radial distribution networks," IEE Proc. D., 141, (4), pp. 291-298, 1994.

[8] Baghzouz Y, Ertem S., "Shunt capacitor sizing for radial distribution feeders with distorted substation voltages", IEEE Trans. Power Deliv., vol.5, 1990, pp. 650-657.

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