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Optimum Location and Sizing of DG with Network Reconfiguration in Distribution System

R. Rajesh, K.Elango, S. Rajanbabu

***Abstract:** A new technique for energy loss reduction for distribution networks is obtainable. It is based onnetwork reconfigurationand algorithms for radial network study. A method for the reconfiguration of distribution system with Distributed Generation (DG) since consistency and power loss is suggested. in this paper below ordinary working situations. Primarily a BPSO algorithm based tie-switches location is conceded out at end nodes taking physical limitations and then preceded by fixing and sizing of DG at the tie-switches location usingFBS optimization method. Before reconfiguration, tie-switch will be in open situation. Reliability at load points is calculated using load flow analysis.Energetic coding is used for discovery the minimal shortcut path from resource to the load. A discover algorithm has been formulate for the network reconfiguration difficulty, since tie-switch and DGs for loss minimization and reliability to improve the load necessity, power stability equations and voltage parameters. The planned approach has been tested on IEEE 33-node radial distribution Networks systems.*

Keywords: Distribution automation, Radial network, Network reconfiguration and Loss minimization.

I. INTRQDUCTION

Radial networks have some leads over interlaced networks such as lesser short circuit currents and meeker switch and defensive equipment. On the supplementary, the radial construction delivers lower thorough consistency and the same time to overcome the complications, distribution Networks are scheduled and built with sensitivity meshed networks, it will have worked as a radial network. The radial network sensations of reconfiguration for loss minimization of power system distribution have been studiedexpansively in the modern years. It is one of the loss minimization method in a distribution Networks is by using the network reconfiguration, it is mandatory for network reconfigure as each of the distribution feeders comprises of industrial, housing and commercialtype loads.

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***** Correspondence Author
R. Rajesh*, M.E, Power system Engineering, SRM Valliammai Engineering College Chennai,India.
K.Elango, Head of the Department, SRM Valliammai Engineering College, Chennai,India.
S. Rajanbabu, Assistant Professor, Electrical and Electronics Engineering Department, SRM Valliammai Engineering College, Chennai, India.

In addition, parts of the sum distribution system convert deeply loaded at definite periods of the day and casually loaded at extra periods, consequently for loss minimization the load currents are requisite to be reorganized extra capably by changing the radial network assembly of the feeders. In previous revisions, reconfiguration has remained used in standard situations to recover system constraints such as power loss, the voltage profile and power assessment.

In several studies [1], reconfiguration was used to return the disturbed loads in alternative environments. Circulated power source is a lesser generating unit straightorganized in distribution system or users adjacent to chance the definitenecessities and maintenance financial process of distribution networkssystem withecological compatibility. And its power ranges from a few kW to fifty MW [2–3]. Distribution network Reconfiguration mentions to the variation of switches arrangement and modification of the configuration of network procedure by opening or closing the sectionals switch and tie switch with limitations fulfilled [4–5].

the topology limit is extant in closely all distribution development and operative development problems. The enactment and effectiveness of network reconfiguration are mainly needy on an effective examine algorithm. PSO technique is a swarm intelligence optimization process., [6-7].

In this paper suggests a reconfiguration approach of radial distribution system with DG. The Initially a BPSO algorithm based tie-switches location is conceded available at end nodes enchanting geographical limitations and then followed by fixing and sizing of DG at the tie-switches placement using FBS optimal technique. Before reconfiguration, tie-switch will be in open situation. Consistency at load opinions is considered using load flow analysis. Energetic encoding is used for discovery the minimal shortcut path from source to the load. A explore technique has been formulate for the network reconfiguration difficulty, since tie-switch and DGs for loss minimization and reliability is improve to meet load necessity, power stability equalities and voltage restrictions. The proposed approach has been tested on IEEE 33-node radial network test distribution systems

II. PROBLEM FORMULATION

This segment deals with the expansion of mathematical model for independent function and altered constrictions for Radial Distribution system reconfiguration with DG.

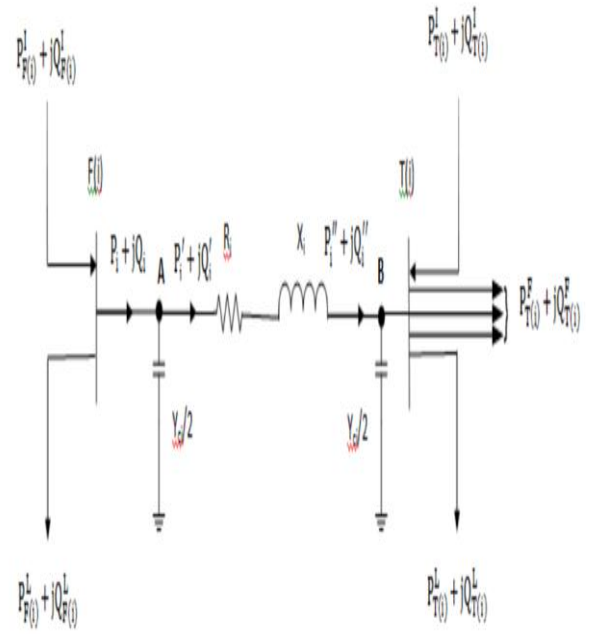

Fig 1: Load Flow Equivalent Circuit

A. Objective function

The objective of the optimum magnitude and position of DG difficult to reduce the entire power loses and voltage magnitude can be stated as [8]

$$P_L = \sum_{i=1}^{N} \cdot \sum_{j=1}^{N} \cdot [a_{ij}(p_i p_j + q_i q_j) + \beta_{ij}(q_i p_j - p_i q_j)] \quad (1)$$

$$\alpha_{ij} = \frac{r_{ij}}{v_i v_j} \cos(\delta_i - \delta_j) \quad (2)$$

$$\beta_{ij} = \frac{r_{ij}}{v_i v_j} \sin(\delta_i - \delta_j) \quad (3)$$

$$Z_{ij} = r_{ij} + jx_{ij} \quad (4)$$

Where,

$Z_{ij} \rightarrow$ impedance of the line

$r_{ij} \rightarrow$ resistanceof the line

$x_{ij} \rightarrow$ reactance of the line

$V_i V_j \rightarrow$ voltage magnitude bus i, bus j

B. Limitations:

The objective function is exposed to the resulting limitations.

Subject to:

Bus voltage parameters: It is recognized that a lesser variation in nodal voltage disturbs the current of reactive power and active power essentially not modification. shown below.

$$V_{imin} \le V_i \le V_{imax} \qquad i\epsilon\{1,2,3, \dots\dots\dots\dots N_b\} \quad (4)$$

V_{imin}, V_{imax} = minimum and maximum voltage limits

Feeder capability parameters: power flow in respective branch necessity be minus than or equal to its determined ability as shown below.

$$|I_i| \le I_{imax} \qquad i\epsilon\{1,2,3, \dots\dots\dots\dots N_b r\} \quad (5)$$

Power flow equation: Total active powerlosses and loadsimilarly entire reactive power generation requirement is equal to sum of entire reactive power lose and load as shown by in this behind equation.

$$\sum P_{igen} = P_L + \sum P_{iLoad} \quad (6)$$

$$\sum Q_{igen} = Q_L + \sum Q_{iLoad} \quad (7)$$

III. PROPOSED METHOD

- Binary Particle Swarm Optimization

BPSO technique established by Kennedy and Eberhart [9] its one of the most used experiential technique to resolve several complications difficulties allied to electrical system. Believe a population comprises of n elements, which is usually 20 in the Radial distribution network reconfiguration. Each particle in the population is searching for optimumresults in a m-dimensional space with a limited speed as the real problematic solution is m-dimension [10]. history pj = (pj1, pj2,...,m), the current position xj = (xj1, xj2,...,xjm), and particle velocity Vj = (Vj1, Vj2,..., Vjm) i = 1, 2, . . . , n.

$$x_i^t = x_i^{t-1} + v_i^t;\ I = 1,2, \dots\dots, P \quad (8)$$

The position of separate particle will be planned and calculated earlier to next iteration giving to the definite problem signified. If the current location is greater to the separate or the finest ever of population location in past, this will be thought as the finest location. For each separate in the population, the repetition method of the speed and location are

$$v_i^t = \omega^{t-1} v_i^{t-1} + \varphi_1 rand_i (pbest_i^{t-i} - x_i^{t-1}) + \varphi_2 rand_{2,i} (gbest^{t-i} - x_i^{t-1}) \quad (9)$$

where $c1$ and $c2$ are the specific learning factor and common learning factor. Their values are nonnegative and range from 0 - 4, which are generally dispersed to 2. The methodology to the global optimum by learning by themselves and the experience of the population. rand is a constant unsystematic number among [0, 1]. Vmax is the maximum velocity of the particle, and the range of Vmax is [−Vmax,Vmax], which is usually the range of particle value per dimension. A reasonable transformation $S(V_i^k)$ is charity to complete this latestvariation where the spot location is defined as surveys [11]

$$X_i^k = \begin{cases} 1, & rand(o) \le S(V_i^{(k)}) \\ 0, & otherwise \end{cases} \quad (10)$$

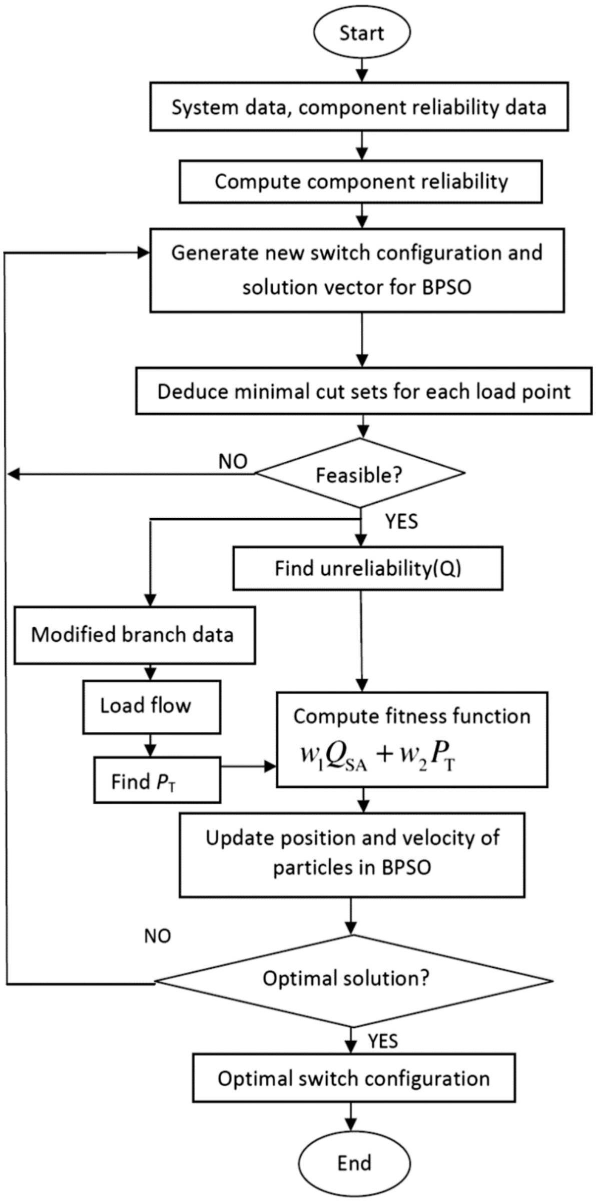

Fig.2.BPSO Flow Chart

The Binary Particle swarm optimization technique is known by Fig.2 where the latest Gbest value characterizes the optimum result of the reconfiguration problem

- Forward Backward Sweeping Method

Forward/backward sweeping-based power flow techniques normally take improvement of the radial network topology of forward and backward sweeping methods. In these type of techniques is established in [12], the forward sweeping is mostly the node voltage calculation from the sending end to the receiving end of the feeder, the backward sweeping is mainly the branch current and power outline from the receiving end to the sending end of the feeder and latera.

Forward branch flow equations

$$P_{s+1} = P_s - R\frac{P_s^2 + Q_s^2}{V_s^2} - P_{Lr} \quad (11)$$

$$Q_{s+1} = Q_s - X\frac{P_s^2 + Q_s^2}{V_s^2} - Q_{Lr} \quad (12)$$

$$V_r^2 = V^2{}_s - 2(RP_s + XQ_s)\frac{P_s^2+Q_s^2|Z|^2}{V_s^2} \quad (13)$$

Backward branch flow equations

$$P_{s+1} = P_s - R\frac{P_r^2 + Q_r^2}{V_r^2} - P_{Lr} \quad (14)$$

$$Q_s = Q_{s+1} - X\frac{P_r^2 + Q_r^2}{V_r^2} - Q_{Lr} \quad (15)$$

$$V_r^2 = V^2{}_r - 2(RP_r + XQ_r)\frac{P_r^2+Q_r^2|Z|^2}{V_r^2} \quad (16)$$

For the merging measures, the determined node voltage incompatibility is calculated in this algorithm to improve for the exhibiting of distributed generations as a PV-bus in the load flow techniques.

IV. SIMULATION RESULTS AND DISCUSSION

The approach defined is this paper has been tested in IEEE 33-Bus Radial Distribution Network system is shown in Fig.3. the System consists of 1 feeder ,32 generally closed sectionalizing switches (1-32) and five normally opened tie line switch (33,34,35,36,37). The system base MVA is 100, system voltage is 12.66 KV, total load 3715kW and 2300kVar.The bus data, load and line data specifics can be referred in [13]. the reconfiguration difficulty, consider tie line -switch and DGs for loss consistency enhancement meeting load requirement,

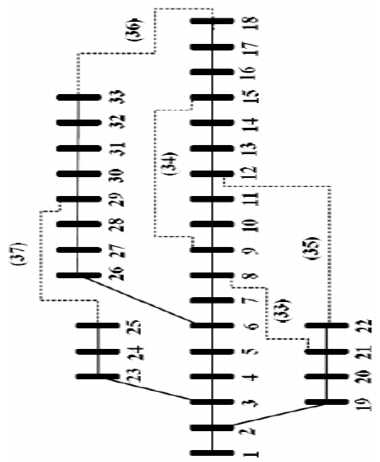

Fig.3 IEEE 33-Bus Radial Distribution Networks system

In this study the 3 dissimilar cases are measured to investigate the enactment of the suggested method

- Case 1:System without reconfiguration and DG (Base case)
  - 1- 32 Sectionalizing switches are closed
  - 33,34,35,36,37 Tie Switches are open
- Case 2: System after reconfiguration using BPSO without adding DG
- Case 3: System with reconfiguration and DG

Case 1:

In this case the system is not reconfigured all the 32 sectionalizing switches are closed and 33,34,35,36,37 tie switches are open this is considering as a base case.as shown in Fig.3.

Case 2:

In this case the system is reconfigured with BPSO techniques numerous times to properly change the population size, the inertia weight, and the number of iterations, the constraints are selected as follows the [14] Table.1

TABLE I: BPSO Parameters

PARAMETERS	BPSO
Population	50
Weighing (W)	0.9 - 0.4
Dimension	4
Max iteration	100
Acceleration coefficients C1 & C2	2 – 2.05

The new configuration is obtained for the distribution networks by using the BPSO as shown in Fig. 5. The measurement of power loss reduction is 32.0564%. After the reconfiguration is process, the voltage becomewell and the power loss compared to the initial condition is decreased. Table. 2.

Case 3:

In this case the Reconfigured distribution networks added with DGs as shown in Fig.5. The DGs is placed in optimal location in the distribution networks by using Forward Backward Sweeping Method in this the stability index is analysis and find the optimal location of DGs from this DG The percentage of power loss reduction is 35.5029%. After the reconfiguration and adding DGs is processed, the voltage becomes better and the power loss compared to the case 1 and case 2 in decreased.as follow the Table 2.

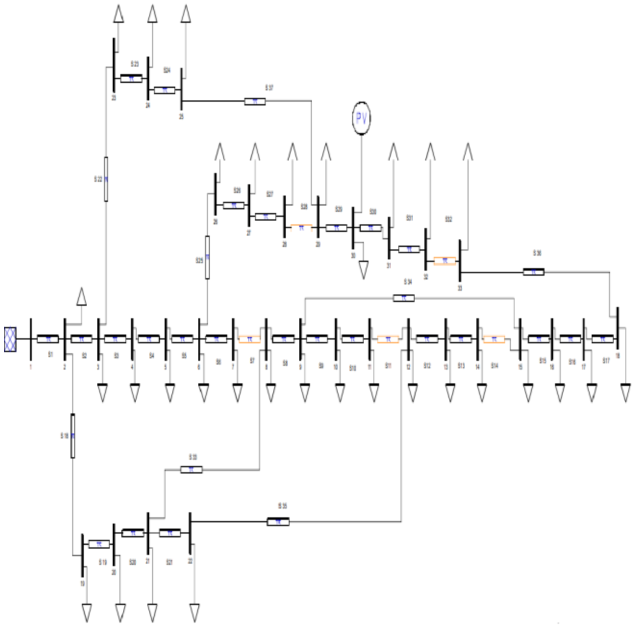

Fig 5: Radial Distribution Networks After Reconfiguration with adding of DGs.

TABLE 2: comparison of power loss

Description	Base Case	After Reconfiguration (BPSO)	With DG
Tie Switches: (33,34,35, 36,37)	open	Closed	Closed
Sectionalizing (1-32)	closed	7,11,14,28,32 Remaining all are closed	7,11,14,28,32 Remaining all are closed
DG Optimum Location	NA	NA	30
DG Optimal Size(kW)	NA	NA	2564
Total Power loss:	208.4592 kW	141.6346 kW	134.45 kW
Power loss reduction (%)	NA	32.0564 %	35.5029%
Minimum voltage:	0.91075 p.u.	0.94127 p.u.	0.9546 p.u.

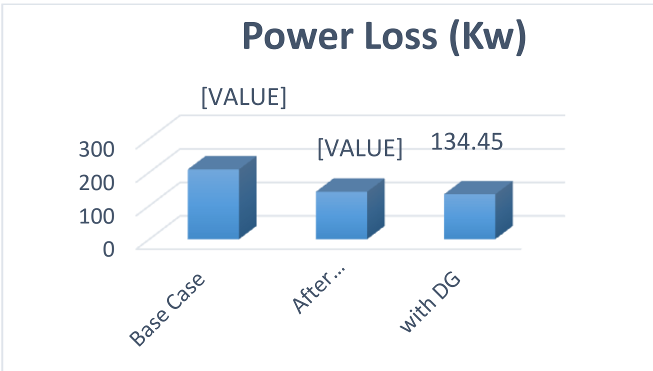

Fig 7: Power Loss Comparison

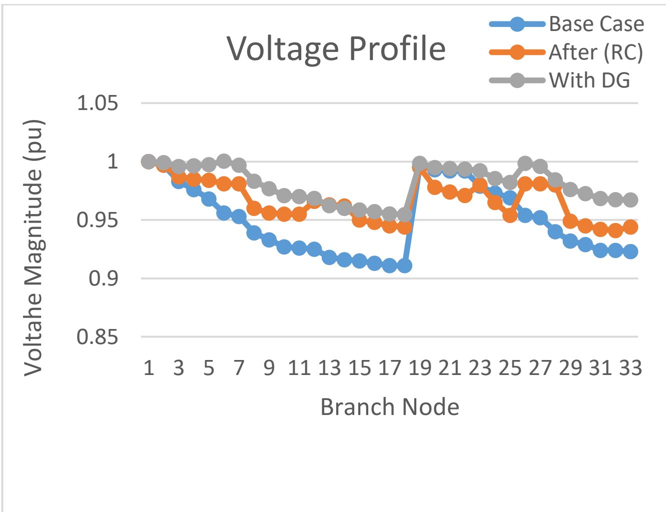

Fig 6: Voltage Magnitude Profile

V. CONCLUDING

In this paper the reconfiguration of radial distribution network is resolved by using Binary Particle swarm optimization and the optimal location and sizing of DG is done by using forward backward sweeping algorithm. The objective of the suggested method is to reduce the active power loss and voltage magnitude deviation. It is issue to maintain the radial nature of the system we use to add some technical constraints. The variables are used to open /close position of the sectionalized switch and tie line switch. The simulation is carried out by using IEEE Single Feeder 33-bus radial distribution network test system is accomplished for reconfiguring of networks efficiently and reduced the active power loss. While reconfiguring the networks, opening or closing some switches resulted in transfer some loads from one feeder to a different feeder, hence overloading. DG is required to support the overloaded feeders for its load carrying capacity. It is envision as expectations work to include distributed generation to support the loaded feeders.

REFERENCES

1. M. H. Shariatkhah, M. R. Haghifam, “Using feeder reconfiguration for congestion management of smart distribution network with high DG penetration”. CIRED workshop 29-30 may 2012.
2. W. El-Khattam and M. M. A. Salama, “Distributed generation technologies, definitions and benefits,” Electric Power Systems Research, vol. 71, no. 2, pp. 119–128, 2004.
3. W. Hongjian and X. Lei, “The dynamic reconfiguration of distribution network with wind turbine and electric vehicle based on genetic algorithm,” Journal of Electrical Engineering, vol. 31, no. 2, pp. 197–220, 2016.
4. W. Jiajia, L. Lin, L. Junyong et al., “Based on improved hierarchical forward and backward substitution method with distributed generation units of distribution network reconfiguration,” Power System Technology, vol. 34, no. 3, pp. 109–112, 2010.
5. Li, Q. Yang, Y. Wei, H. Luo, and Q. Zhang, “Distribution network reconfiguration method considering the correlation between wind speed and load,” DianliZidonghuaShebei/Electric Power Automation Equipment, vol. 36, no. 2, pp. 148–153, 2016.
6. Y. L. Mei, X. Mingxia, X. Jianjun et al., “Power flow algorithm for distribution network with distributed generation,” Power System Protection And Control, vol. 41, no. 5, pp. 18–22, 2013.
7. J. Mendoza, R. Lopez, D. Morales, E. Lopez, P. Dessante, and R. Moraga, “Minimal loss reconfiguration using genetic algorithms with restricted population and addressed operators: Real application," IEEE Trans. Power System, vol. 21,pp. 948-954, May 2006.
8. Jin, J. Zhao, Y. Sun, K. Li, B. Zhang, “Distribution Network Reconfiguration for Load Balancing using Binary Particle Swarm Optimization”, International Conference on Power System Technology, vol. 1, no. 1, Nov. 2004, pp. 507-510
9. Mohammad Ali Hormozi, Mohammad BarghiJahromi, GholamrezaNasiri and Hossein Karimianfard “Optimal Network Reconfiguration and Distributed Generation Placement in Distribution System Using a Hybrid Algorithm”, International Journal of Energy and Power Engineering, Vol. 5, No.5, pp.163-170, 2016.
10. P. Bernardon, A. P. C. Mello, L. L. Pfitscher, L. N. Canha, A. R. Abaide, and A. A. B. Ferreira, “Real-time reconfiguration of distribution network with distributed generation,” Electric Power Systems Research, vol. 107, pp. 59–67, 2014.
11. Y. Shi et al., “Particle swarm optimization: developments, applications and resources,” In : evolutionary computation, 2001. Proceedings of the 2001 Congress on. IEEE, pp. 81–86, 2001
12. U. Eminoglu a & M. H. Hocaoglu b “Distribution Systems Forward/Backward Sweep-based Power Flow Algorithms: A Review and Comparison Study” Electric Power Components and Systems,Vol. 37,pp91–110, 2009.
13. Y.C.Huang, “Enhanced genetic algorithm-based fuzzy multi objective approach to distribution network reconfiguration”, Proc. Inst .Elect. Eng. Vol.149, No.5, pp.615–620,2002.
14. M. Alonso, H.Amarís, B. Rojas, D. Della Giustina, A. Dedè and Z. Al-Jassim “Optimal network reconfiguration for congestion management optimization in active distribution networks” In International Conference on Renewable Energies and Power Quality (ICREPQ’16), ISSN 2172-038 X, Vol.1, No.14 May 2016.

AUTHORS PROFILE

Mr. Rajesh R is pursuing his M.E in power system Engineering from SRM Valliammai Engineering CollegeChennai,India. He completed B.Tech (Electrical and Electronics Engineering) in SRM University, Ramapuram, Chennai, India. He has 2 years of experience in industries. His area of interest is power system, Transmission &Distribution, and flexible AC transmission system. (rajeshmakesh16@gmail.com)

Dr K Elango received his B.E. degree in Electrical and Electronics Engineering from AlagappaChettiar College of Engineering and technology, Madurai Kamaraj University, Karaikudi, Tamilnadu, India in 1998. He received his M.E. degree in Power System Engineering from Annamaliai University, Chidambaram, Tamilnadu, India in 2000. He received his Ph.D. degree in Congestion Management in Restructured Power System from CEG, Anna University, Chennai, Tamilnadu, India in 2012. During his outstanding academic career spanning 20 years, he served as a Professor as well as Head of the Department in SRM Valliammai Engineering College. He is a member of the Board of studies of Department of Electrical and Electronics Engineering. He is a Member of the Academic Council of SRM Valliammai Engineering College. He has published several technical papers in national and international Journal and Conference. His current research interests include the Power Systems, Congestion Management, Solar Energy, Soft Computing Techniques. He is a Chartered Engineer and Fellow Member of IE(I). He is a Senior Member of the IEEE, ISTE and ISC. (elangok.eee@valliammai.co.in)

Prof. Mr. S. Rajanbabu is working as an Assistant Professor in Electrical and Electronics Engineering Department, SRM Valliammai Engineering College, Chennai, India. He Pursuing His Ph.D. in faculty of Electrical Engineering Department, Anna University. He completed M.E (Power system) in Annamalai University and B.E (Electronics and Communications Engineering) in Arunai Engineering College, Madras University. His area of research is Power system. (rajanbabu03@gmail.com)