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COMPARATIVE STUDY OF PSO, JAYA AND RAO ALGORITHMS FOR OPTIMAL ALLOCATION OF DG IN POWER SYSTEM NETWORKS

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Abstract
The competent, affordable, and dependable operation of electrical power system networks be contingent on location and sizing of distributed generation (DG) at their optimum levels. The appropriate operation of "electrical power system networks" requires best DG allocation. The two focal goals for certifying the safe operation of power system networks are to lower active power losses and improve the overall voltage profile. In this paper, a comparison of JAYA, RAO, and Particle Swarm Optimization (PSO) Algorithms' optimal distribution of distributed generation has been conceded out. Type -1 Distributed Generation (DG) is employed in this and the ideal losses in IEEE-9 bus system are 2.9443 MW for JAYA, 2.9404 MW for PSO, and 2.9405 MW for the RAO algorithm. The thoroughgoing losses in the IEEE-14 bus system are likewise almost identical and are 3.4772 MW for PSO, 3.4783 MW for JAYA, and 3.4775 MW for RAO Algorithm. The optimum losses in the IEEE-30 bus system are equally almost identical and are 1.5848 MW for PSO, 1.5848 MW for JAYA, and 1.5850 MW for RAO Algorithm and when compared to other algorithms, the RAO method advances the voltage profile significantly. With the use of the Matlab Toolbox and Mat-Power 6.0, the PSO, JAYA, and RAO algorithms are used to allocate DG in the preeminent probable way.
Keywords- Distributed Generation, Optimal Location of DG, Optimal Size of DG, Particle Swarm Optimization, JAYA and RAO

INTRODUCTION

Distributed generation (DG), a compact generator dispersed throughout a power system network, provides localised electricity to load users [1]. Applications for DG can be found in the commercial, residential, and industrial sectors. In some instances, modern DG technology can hold its own against traditional huge generators since it is more efficient, dependable, and simple [2–3]. The emergence of smart-grid technology and the eventual acceptance of distributed generating have recently resulted in significant modifications to the power industry's distribution power system. Distributed generation refers to the decentralization of power facilities through the deployment of smaller producing units—often 10 megawatts or less—closer to the point of consumption (DG). Even though the idea of DG is not new, it is becoming more and more popular due to deregulation, environmental concerns, and national security considerations. There are no installed generation units in the radial distribution system. Electricity is sent from the Grid Supply Point to the distribution network. Thus, power travels through a single path from "transmission to distribution". Distributed generation of electricity is the process of connecting a growing number of generators to the distribution network. The distribution system's performance is influenced by where and how much power the DG injects into the system. They have the power to affect the system's stability and efficiency in either direction. The DG's potent output allows for the reversal of even electrical flow. The DG is then chosen in its ideal size and location. In [4-5], the particle swarm optimization method is used to identify the best location for a specific size DG. The main objective is to reduce system losses. To reduce the overall losses of the distribution network, the dominant locus and DG size are carefully considered in this study. The energy generation sector is experiencing new challenges as a result of technological development, environmental legislation, and the growth of the financial and electrical markets [6–8]. Due to recent technological advancements, small plants can now generate electricity. In order to lessen the environmental impact of power generation, new electrical energy distribution techniques are being developed and implemented as the use of renewable energy sources rises [9–10].

In this new paradigm, the generation is no longer constrained to level 1. Therefore, a portion of the energy demand is met by centralized generation, and the other component is met by distributed generation. Electricity will be produced nearby users. The electrical system that links the consumer's meter to the substation of the transmission system is known as the distribution system. The crucial parts of a distribution system include feeders, distributors, and service mains. The "diagram of a typical low tension distribution system" is a single line that is displayed in figure 1[11-12].

DISTRIBUTED GENERATION

A new designation for "distributed generation" appeared on the electric system map as a result of "deregulation in the electric power sector" (DG). A novel method of supplying electricity to the grid's core is known as distributed generation (DG). The installation of a variety of small, portable, and eco-friendly electric power generators is what it depends on the most.

According to current technology, the tendency in electric power generation is to use distributed generation units with sizes between "KW and MW at load locations" rather than antiquated federal generation units with sizes between "100 MW and several GW" [13–15]. Numerous benefits, such as excellent fuel efficiency and quick implementation periods, are provided by these distributed technologies, which contribute to their rising popularity. If you think about how the first power Utilities produce and transport electricity within a specifically designated area. The massively networked system led to the emergence of national or regional grids, which improved the affordability and dependability of electrical networks [16–18]. Despite the fact that hydro power plants are recognised to be environmentally friendly, new issues have recently cropped up in the power industry, such as the challenge of finding new areas for them. Furthermore, certain countries, such as Germany and Sweden, have passed laws requiring the closure of nuclear power plants, and it is not anticipated that these facilities will be replaced. Additionally, in the nominally deregulated power industry, it is challenging to convince market participants to invest billions of dollars in power generating and transmission projects with lengthy payback periods.

Due to these challenges, as well as the liberalization of the electrical industry and the decentralization of the power system, DG has received favorable reviews from a range of groups, including consumers, distributors, power producers, regulators, and researchers [19–20]. In order to decrease power losses, enhance voltage profiles and load factors, remove the need for system upgrades, and increase system integrity, reliability, and efficiency, various distributed generation (DG) devices can be installed strategically in the grid.

The best size and placement of DG were determined using the "particle swarm optimization technique" in order to reduce system power losses, maintain voltage control at each bus, and maintain a constant system frequency. Only solar, microturbine, and fuel cell systems that are wired into the main grid via converters or inverters can produce active electricity using the type-1 DG. However, photovoltaics can and are occasionally required to generate reactive electricity as well, depending on the present situation and grid rules. The Type- 2 DG with ability to provide both of “active and reactive” power. Only reactive power can be delivered by Type-3 DGs. Gas turbines are an example of synchronous compensators, which run at zero power factors. The Type- 4 DG with ability to deliver active power while consuming the reactive power. This category mostly includes induction generators, which are commonly employed in wind farms [21].

PARTICLE SWARM OPTIMIZATION (PSO)

The Kennedy and Eberhart described “Particle Swarm Optimization (PSO)” approach for the first time in 1995. The “Particle Swarm Optimization algorithm” is a multiple-agent with parallel search strategy that preserves a throng of particle’s which signifies “potential swarm” solution [22]. At each step t, if xit denotes the “position vector” of particle I in the multi-dimensional pursuit space (i.e. Rn), then the location of every particle in exploration cosmos is updated by,

$$[\quad x_i^{t+1} = x_i^t + v_i^{t+1} \quad \text{with} \quad x_i \sim U(x_{min}, x_{max}) \quad]$$

Where,

vit is the “particle's velocity vector”, which initiatives the “optimization process and reflects both the particle's own experience knowledge and the collective experience knowledge of all particles U(xmin, xmax) is the uniform distribution, with xmin and xmax being its minimum and maximum values, respectively”. In this paper, “global best PSO (or gbest PSO)” is a process and situation for every particle is prejudiced through finest-fit particle’s in entire swarm.

It gathers social information from every particle in the swarm using a star social network topology. Every particle in this process has a personal best position in search space, Pbest,i, where n>1, a personal best position in search space, xi, and a current velocity, vi. The ideal location for you There is a minimization issue since Pbest,i agrees with the situation where particle I had the lowest value as determined by objective function f. Additionally, the position with the lowest value among all the personal bests is the global best position, represented by Gbest [23]. Pbest,i. The equations that follow show how these changes affect both individual and planetary optimal values. When dealing with minimization issues, Pbest,i at time step t+1. The "global best position Gbest" at time step t is calculated as,

$$G_{best} = \min\{P_{best,i}\}, \text{ where } i \in [1,\ldots,n] \text{ and } n>1$$

As a result, it's crucial to remember that Pbest,i is the particle's best location since the first time step. Gbest, on the other hand, is the best position discovered by any particle in the entire swarm. The typical PSO technique is used to compute particle velocity.

$$V_{ij}^{t+1} = v_{ij}^{t} + c_1 r_1 [P^{t}_{best,i} - x^{t}_{ij}] + c_2 r_2 [G_{best} - x^{t}_{ij}]$$

$$\begin{matrix} P_{best,i}^{t} & \text{if } f(x_i^{t+1}) > P_{best,i}^{t} \\ x_i^{t+1} & \text{if } f(x_i^{t+1}) <= P_{best,i}^{t} \end{matrix}$$

Where,

"Vtij is the velocity vector, of particle i in dimension j at time t, xtij is the position vector of particle in dimension j at time t, Ptbest,i is the personal best position of particle i in dimension j found from initialization through time t, Gbest is the global best position of particle i in dimension j found from initialization through time t", C1 and C2 are "position acceleration constants" and r1 and r2 are random integers from the uniform distribution U(0,1) at time t, which are used to level the contribution.

We discover that the DG is placed with "optimal size at optimal bus location" when the PSO approach is used. In parallel with improving the "overall voltage profile of the power system network" in comparison to power system networks without using DG, the total power losses are reduced throughout this process. For this, we use the IEEE9, IEEE14, and IEEE30 test bus systems. The "gbest PSO" algorithm can be seen in the flowchart.

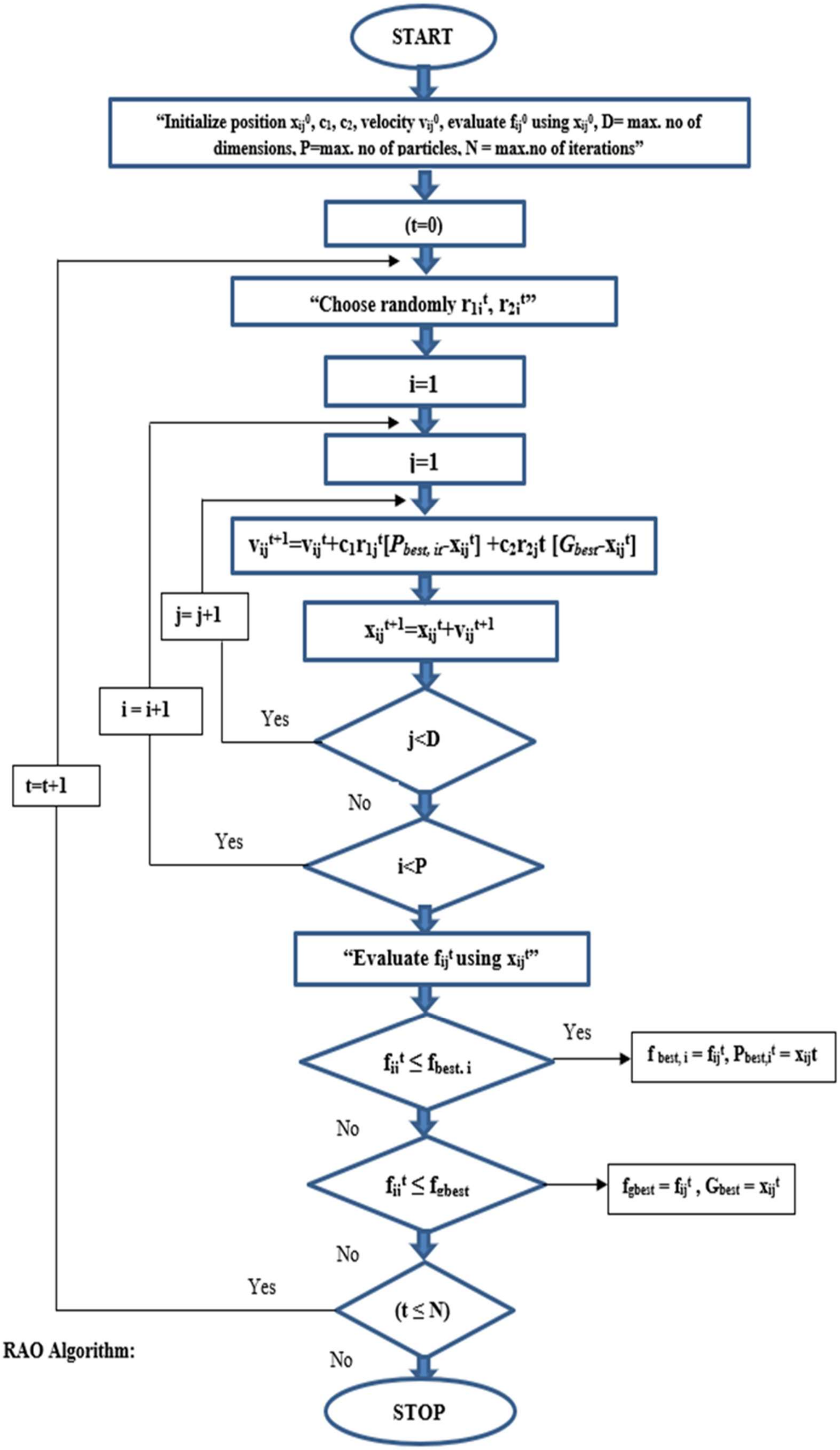
JAYA ALGORITHM

The word "JAYA" is derived from the ancient Indian language "Sanskrit." This indicates success. The Jaya algorithm's qualities are obvious from the name alone. The Jaya algorithm seeks to prevail by dominating the worst solution and locating a key that is nearby to the global optimal clarification. RAO made JAYA algorithm suggestion (2016). The technique was initially created to solve benchmark issues that were both confined and uncontrolled. The Jaya algorithm has also been used in other engineering optimization fields, such as the design of heat exchangers and mechanical components and the improvement of manufacturing processes. The Jaya algorithm's operation is described as follows. Assume any objective which is to be optimized and it id denoted by f(x). Let objective function is having DV design mutable (j= 1,2…..DV), Let NP is the size of initial solutions (k=1…….NP).

Firstly, generate NP Initial solutions based on this given boundary conditions. Now, at any iteration i, if the greatest clarification obtained in the entire solution is f(x)best and the worst solution obtained is f(x)worst , then solution during the ith iteration then the parameters will be modified as per the following equation.

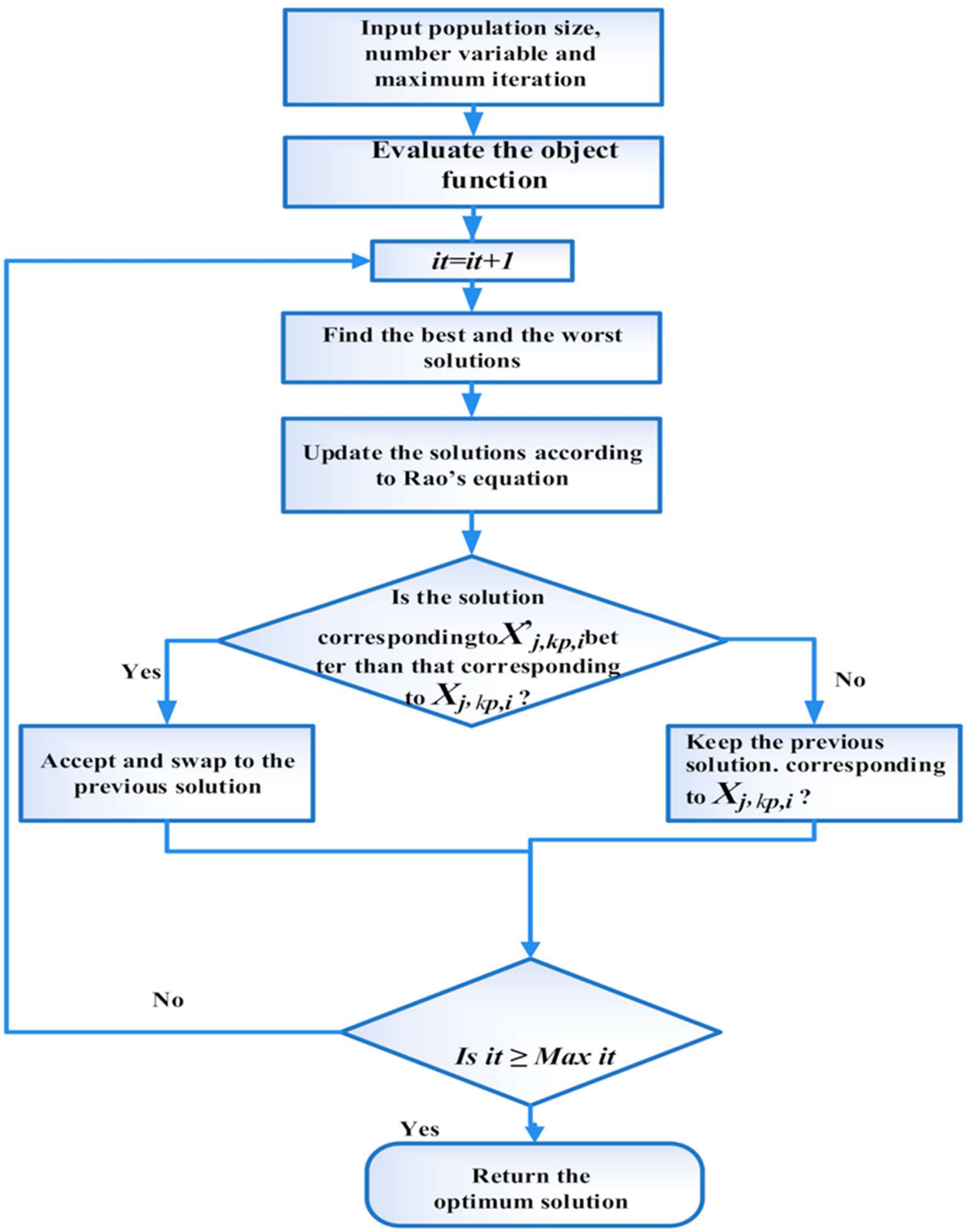
Xi'j,k = Xij,k + rand1 (- |Xij,k) – rand2 (Xij,worst - |Xij,k|)

Here, Xij,k is the value of the jth variable for the kth candidate during, Xij,best is the value of design variable jth variable corresponding to the best solution. Similarly, Xij,worst is the value of design variable of jth variable corresponding to the worst solution. The rand1 and rand2 are two random numbers between 0 and 1. Above Xi'j,k is accepted if and only if the corresponding function value is enhanced than the previous value else Xij,k is kept as it is. All the accepted values of parameters based on the acceptance of modified solution are kept and these works as the input to the next iteration. Furthermore, above procedure is repetitive till the termination criterion is not extended.



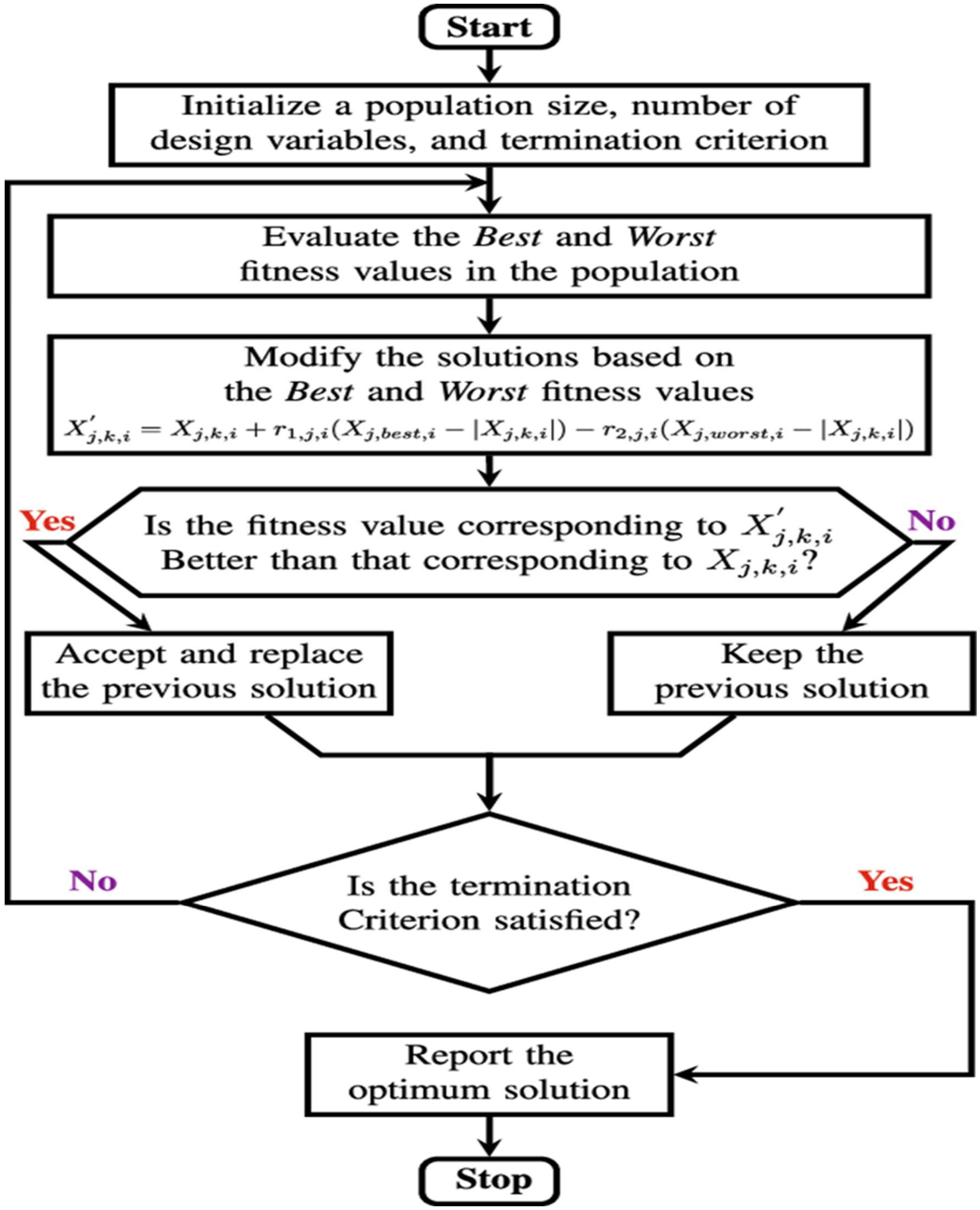
Flow chart of PSO Algorithm

RAO Algorithm:



Flow chart RAO Algorithm

JAYA Algorithm:



Flow char for Jaya Algorithm

OBJECTIVE FUNCTION

The basic ordinary kind of Optimal Power Flow complications proceeds the subsequent form.

subject to,

$\min f_{(a)}$ 1.0

$X_{(a)} = 0$ 1.1

$Y_{(a)} \leq 0$ 1.2

$a_{min} \leq a \leq a_{max}$. 1.3

Where, equations 1.1 to 1.3 are known as equality constrains, inequality constraints and limit to design variables.

The Standard form of AC OPF:

The "optimization vector, a for the standard form of AC OPF" problem involves of the [nb × 1] vector's of "voltage angles α and magnitudes Vm" with real and reactive power is [ng × 1] vector's of generator real and reactive power injections Pg and Qg.

$$a = [\alpha \;\; Vm \; Pg\,]$$

The objective function for the allocation of DG which is 1.0, basically addition of separate polynomial cost

functions f j and fj

of " real and reactive power injections", correspondingly, for every generator.

$$\min_{\alpha, V_m, P_g, Q_g} \sum_{j=1}^{ng} f_P^j(p_g^j) + f_Q^j(q_g^j). \quad 1.4$$

The equality constraints are the 2 nb nonlinear real and reactive power balancing equations in their entirety. The inequality constraints are made up of two sets of nl "branch flow limitations", one for the from end and one for the to end of every branch, that are nonlinear functions of "bus voltage angles" and magnitudes.

$$[h_f(\alpha, V_m) = |F_f(\alpha, V_m)| - F_{max} \leq 0] \quad 1.5$$

$$[h_t(\alpha, V_m) = |F_t(\alpha, V_m)| - F_{max} \leq 0] \quad 1.6$$

The flow's are characteristically deceptive power flow's uttered in MVA, but can be "real power or current flow's" resilient the subsequent three conceivable form's for the flow constraints.

$F_f(\alpha, V_m) = Sf(\alpha, V_m)$, apparent power

$Pf(\alpha, V_m)$, real power

$I_f(\alpha, V_m)$, current

RESULTS & DISCUSSION:

IEEE 9 Bus System for Bus Voltage:

Figure 1 illustrates a comparison of voltage profiles after the installation of various techniques in power system networks. When compared to DG "type-1, for PSO, JAYA and RAO with and without the usage of DG, RAO is more noticeable. The overall power loss after connecting the various techniques is nearly identical for PSO (2.9404 MW), JAYA (2.9443 MW) and RAO (2.9405 MW), with the use of DG. The usage of RAO for type-1 DG is more effective from the standpoint of improving voltage profiles but less effective when there is a general loss of power in power system networks.

Table no - 1 IEEE 9 Bus Systems for Bus Voltage

Bus No.	Voltage Without DG	Voltage With DG		
		PSO	Jaya	Rao
		With DG		
1	1	1	1	1
2	1	1	1	1
3	1	1	1	1
4	0.987	0.9907	0.9907	0.9907
5	0.9755	0.9797	0.9796	0.9797
6	1.0034	1.0038	1.0037	1.0038
7	0.9856	0.9866	0.9865	0.9867
8	0.9962	0.9974	0.9973	0.9975
9	0.9576	0.9645	0.9645	0.9645

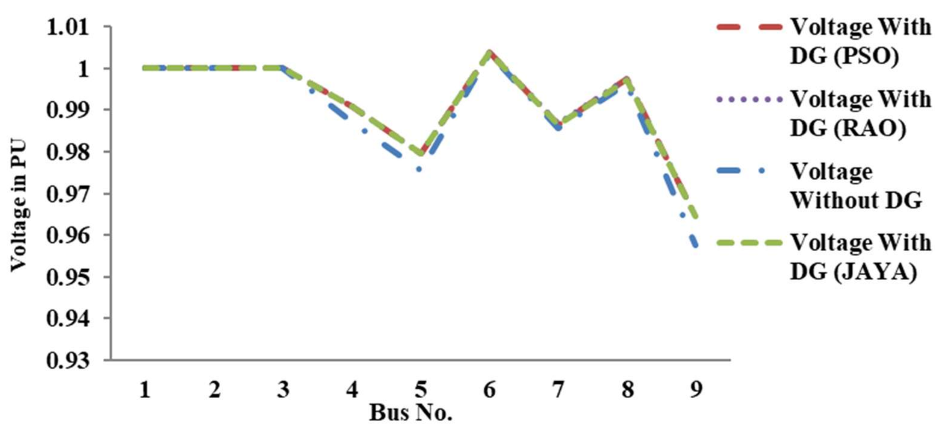


Fig.1 IEEE 9 Bus voltage profile with and without installation of DG

Table no-2 IEEE 9 Bus System for power loss

Branch No.			Branch loss without DG	Branch loss with DG		
Branch No.	From	To		PSO	Jaya	Rao

1	**1**	**4**	**0**	**0**	**0**	**0**
2	**4**	**5**	**0.1736**	**0.6359**	**0.6297**	**0.5592**
3	**5**	**6**	**1.4486**	**0.384**	**0.3908**	**0.4779**
4	**3**	**6**	**0**	**0**	**0**	**0**
5	**6**	**7**	**0.0955**	**0.3683**	**0.3645**	**0.3247**
6	**7**	**8**	**0.5062**	**0.19**	**0.1923**	**0.2203**
7	**8**	**3**	**0**	**0**	**0**	**0**
8	**8**	**9**	**2.4645**	**0.4308**	**0.4416**	**0.5780**
9	**9**	**4**	**0.2663**	**0.9313**	**0.9217**	**0.8185**

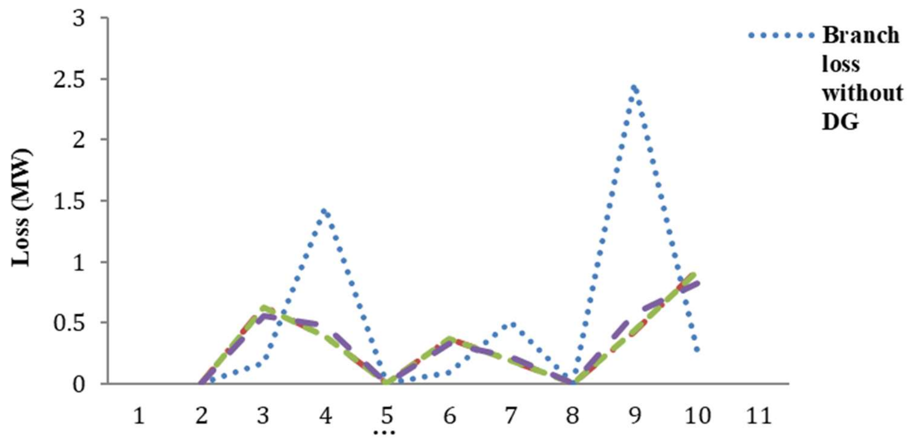


Fig.2 IEEE 9 system network power losses with and without installation of DG

Table. 3 Comparison of PSO, JAYA and RAO at various specifications

Sr. No	Loss without DG	LOSS WITH DG	OPTIMAL LOCATION	OPTIMAL SIZE(P)	Q
PSO	**4.955**	**2.9404**	**2**	**-83.3582**	**0**
JAYA	**4.955**	**2.9443**	**2**	**-86.9876**	**0**
RAO	**4.955**	**2.9405**	**2**	**-82.7403**	**0**

IEEE 14 Bus System for Bus Voltage:

Figure 3 illustrates a comparison of voltage profiles after the installation of various techniques in power system networks. When compared to DG "type-1, for PSO, JAYA and RAO with and without the usage of DG, JAYA is more noticeable. The overall power loss after connecting the various techniques is nearly identical for PSO (3.4772 MW), JAYA (3.4783 MW) and RAO (3.4775 MW), with the use of DG. The usage of JAYA for type-1 DG is more effective from the standpoint of improving voltage profiles but less effective when there is a general loss of power in power system networks.

Table no - 4 IEEE 14 Bus Systems for Bus Voltage

Bus No.	Voltage Without DG	Voltage With DG		
		PSO	Jaya	Rao
		With DG		
1	1.06	1.06	1.06	1.06
2	1.045	1.045	1.045	1.045
3	1.01	1.01	1.01	1.01
4	1.017670854	1.043591	1.038387	1.037466879
5	1.01951386	1.037108	1.0363	1.033285459
6	1.07	1.07	1.07	1.07
7	1.061519532	1.074081	1.070147	1.071096492
8	1.09	1.09	1.09	1.09
9	1.055931721	1.069298	1.071058	1.066093294
10	1.050984625	1.062248	1.063986	1.059545767
11	1.056906519	1.062863	1.063996	1.061432565
12	1.055188563	1.056046	1.055218	1.055846014
13	1.050381714	1.052528	1.053118	1.052011613
14	1.035529946	1.044188	1.044918	1.042114571

Fig.3 IEEE 14 Bus voltage profile with and without installation of DG

Table no-5 IEEE 14 Bus System for power loss

Branch No.			Branch loss without DG	Branch loss with DG		
Branch No.	From	To		PSO	Jaya	Rao
1	1	2	4.2976	0.186157	0.384974	0.65371
2	1	5	2.762873	0.086005	0.169227	0.38735
3	2	3	2.323269	0.87751	1.076964	1.183132
4	2	4	1.676658	0.006372	0.03103	0.086296
5	2	5	0.903753	0.015919	0.028766	0.109168
6	3	4	0.373445	1.70953	1.398873	1.255352
7	4	5	0.51442	0.120038	0.006174	0.012893
8	4	7	1.07E-14	7.11E-15	0	1.07E-14
9	4	9	0	-3.55E-15	1.78E-15	0
10	5	6	7.11E-15	7.11E-15	-1.78E-15	0
11	6	11	0.055373	0.013889	0.182114	0.021733
12	6	12	0.071809	0.062406	0.045639	0.064727
13	6	13	0.212085	0.166616	0.092467	0.177708
14	7	8	0	8.67E-17	3.47E-16	-1.73E-16
15	7	9	0	-7.11E-15	1.42E-14	0
16	9	10	0.012875	0.03147	0.170359	0.025907

17	**9**	**14**	**0.116154**	**0.181507**	**0.530433**	**0.163348**
18	**10**	**11**	**0.012581**	**0.0001**	**0.206338**	**0.000958**
19	**12**	**13**	**0.006298**	**0.003178**	**0.008018**	**0.003847**
20	**13**	**14**	**0.054078**	**0.016452**	**0.112156**	**0.024018**
Total Loss			**13.39327**	**3.47715**	**4.443532**	**4.170147**

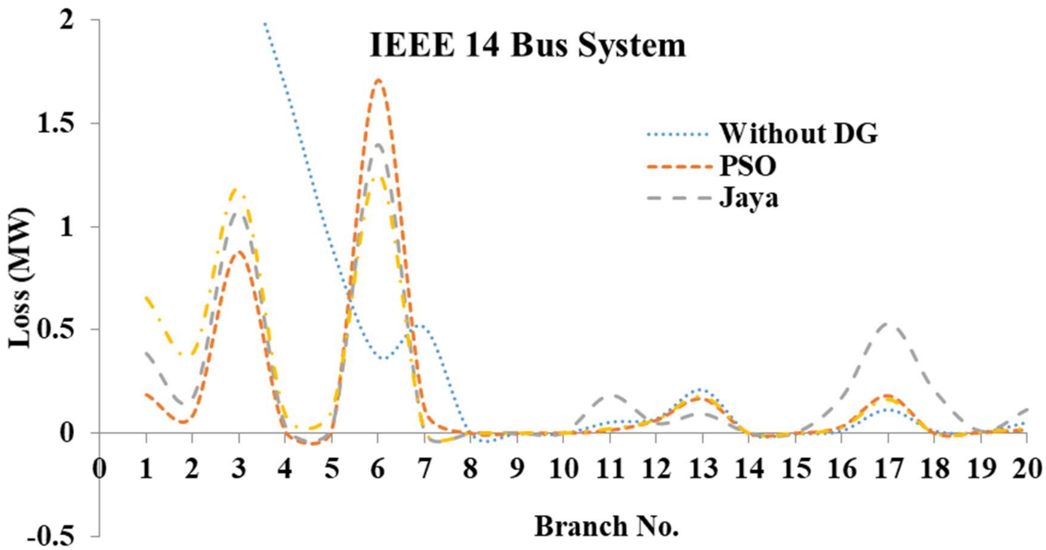


Fig.4 IEEE 14 system network power losses with and without installation of DG

Table. 6 Comparison of PSO, JAYA and RAO at various specifications

Sr No	Loss without DG	LOSS WITH DG	OPTIMAL LOCATION	OPTIMAL SIZE(P)	Q
PSO	13.393	3.4772	4	184.6134	0
JAYA	13.393	3.4783	4	186.6839	0
RAO	13.393	3.4775	4	183.4259	0

IEEE 30 Bus System for Bus Voltage:

Figure 5 illustrates a comparison of voltage profiles after the installation of various techniques in power system networks. When compared to DG "type-1, for PSO, JAYA and RAO with and without the usage of DG, RAO is more noticeable. The overall power loss after connecting the various techniques is nearly identical for PSO (1.5848 MW), JAYA (1.58483 MW) and RAO (1.5850 MW), with the use of DG. The usage of RAO for type-1 DG is more effective from the standpoint of improving voltage profiles but less effective when there is a general loss of power in power system networks.

Table: 7 IEEE 30 Bus Systems for Bus Voltage

Bus No.	Voltage Without DG	Voltage With DG		
		PSO	Jaya	Rao
2	1	1	1	1
3	0.983138289	0.987128	0.987135	0.987147994
4	0.980092995	0.984754	0.984762	0.984777996

5	**0.982406197**	**0.984636**	**0.98464**	**0.984646732**
6	**0.973184021**	**0.978937**	**0.978947**	**0.978966771**
7	**0.967355448**	**0.971866**	**0.971874**	**0.971888982**
8	**0.960623708**	**0.966422**	**0.966433**	**0.966452411**
9	**0.980506117**	**0.984578**	**0.984585**	**0.98459673**
10	**0.984404296**	**0.987804**	**0.98781**	**0.987821415**
11	**0.980506117**	**0.984578**	**0.984585**	**0.98459673**
12	**0.985468317**	**0.983912**	**0.983907**	**0.983898948**
13	**1**	**1**	**1**	**1**
14	**0.976676834**	**0.975123**	**0.975119**	**0.975110413**
15	**0.980229029**	**0.980056**	**0.980055**	**0.980052352**
16	**0.977395655**	**0.978429**	**0.978429**	**0.978430778**
17	**0.97686541**	**0.979756**	**0.979761**	**0.979769581**
18	**0.968440329**	**0.969951**	**0.969953**	**0.969957174**
19	**0.96528704**	**0.967488**	**0.967492**	**0.967498064**
20	**0.969166351**	**0.971635**	**0.971639**	**0.971646164**
21	**0.993383297**	**0.994178**	**0.994179**	**0.994182149**
22	**1**	**1**	**1**	**1**
23	**1**	**1**	**1**	**1**
24	**0.988566296**	**0.988033**	**0.988032**	**0.988028912**
25	**0.990214837**	**0.989874**	**0.989873**	**0.989870761**
26	**0.97219415**	**0.971847**	**0.971845**	**0.971843551**
27	**1**	**1**	**1**	**1**
28	**0.9747149**	**0.980334**	**0.980344**	**0.980363412**
29	**0.979596705**	**0.979597**	**0.979597**	**0.979596705**
30	**0.967882879**	**0.967883**	**0.967883**	**0.967882879**

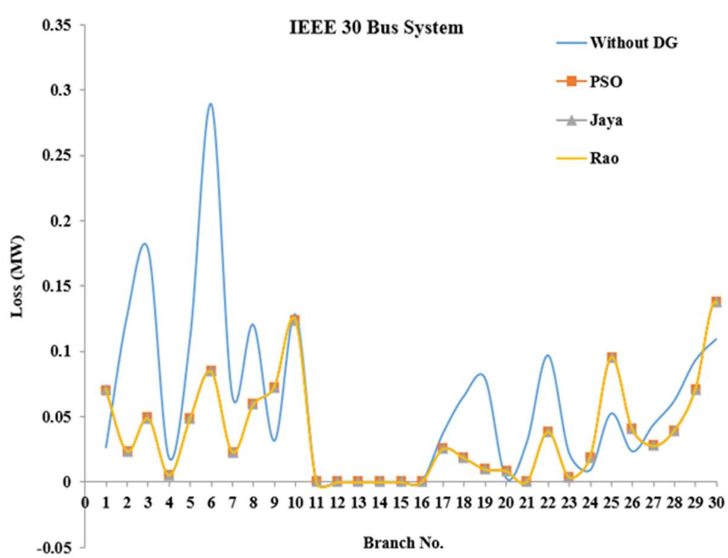


Fig: 5 IEEE 30 Bus voltage profile with and without installation of DG

Table: 8 IEEE 30 Bus System for power Loss

Branch No.			Branch loss without DG	Branch loss with DG		
Branch No.	From	To		PSO	Jaya	Rao
1	1	2	0.026293	0.070145	0.070628	0.071536
2	1	3	0.126695	0.02368	0.023727	0.023819
3	2	4	0.178006	0.049162	0.049031	0.048788
4	3	4	0.018291	0.005205	0.00523	0.005279
5	2	5	0.110265	0.048858	0.048765	0.048592
6	2	6	0.289202	0.085089	0.084875	0.084478
7	4	6	0.066192	0.023178	0.023129	0.023038
8	5	7	1.20E-01	5.96E-02	0.05947	5.93E-02
9	6	7	0.031419	7.27E-02	7.28E-02	0.073008
10	6	8	1.28E-01	1.24E-01	1.24E-01	0.124008
11	6	9	0	0	-1.78E-15	1.78E-15
12	6	10	-4.44E-16	-8.88E-16	0	1.78E-15
13	9	11	0	0	0	0
14	9	10	0	-1.78E-15	-1.78E-15	0.00E+00
15	4	12	0	0.00E+00	0.00E+00	-1.78E-15
16	12	13	0	0	0	-7.11E-15
17	12	14	0.036824	0.025361	0.02534	0.025301
18	12	15	0.065553	0.018706	0.018637	0.01851
19	12	16	0.079537	0.010014	0.009948	0.009826
20	14	15	0.003141	0.008644	0.008662	0.008697
21	16	17	0.030672	0.000408	0.000417	0.000435
22	15	18	0.096814	0.038876	0.038787	0.03862
23	18	19	0.022098	0.003808	0.003788	0.00375
24	19	20	0.008904	0.018775	0.018806	0.018864
25	10	20	0.052365	0.095201	0.095322	0.095549
26	10	17	0.023393	0.040606	0.040672	0.040795
27	10	21	0.043685	0.027821	0.027806	0.027778
28	10	22	0.062162	0.039498	0.039467	0.039408
29	21	22	0.0931	0.070769	0.07073	0.070658
30	15	23	0.109361	0.137354	0.137427	0.137563
31	22	24	0.078267	0.036798	0.036815	0.036848
32	23	24	0.066278	0.040681	0.040639	0.04056
33	24	25	0.034988	0.000444	0.000444	0.000445
34	25	26	0.046394	0.046427	0.046427	0.046428
35	25	27	0.062563	0.024844	0.024807	0.024737
36	28	27	8.88E-16	1.78E-15	0	0
37	27	29	0.090096	0.090096	0.090096	0.090096
38	27	30	0.171305	0.171305	0.171305	0.171305
39	29	30	0.034876	0.034876	0.034876	0.034876
40	8	28	0.035625	0.038827	0.038835	0.03885

41	**6**	**28**	**0.001172**	**0.00309**	**0.003099**	**0.003115**

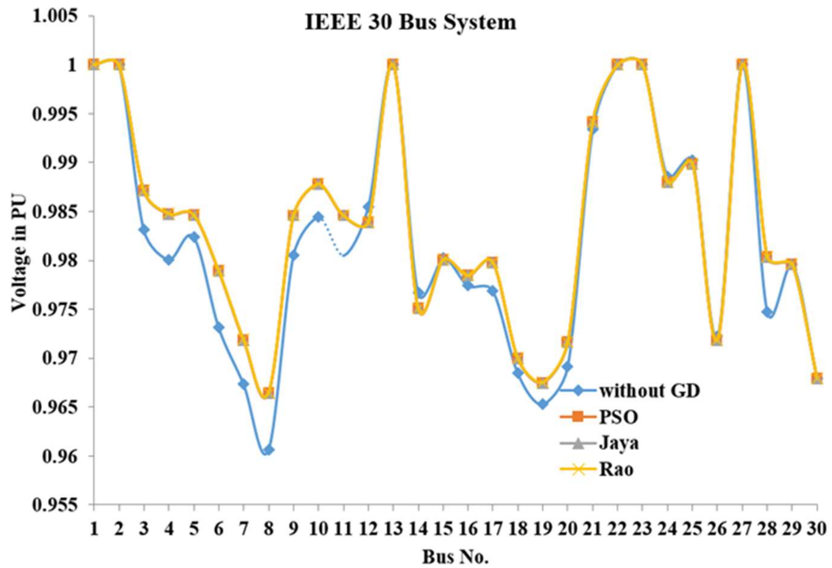


Fig: 6 IEEE 30 system network power losses with and without installation of DG

Table. 9 Comparison PSO, JAYA and RAO at various specifications

Sr No	Loss without DG	LOSS WITH DG	OPTIMAL LOCATION	OPTIMAL SIZE (P)	Q
PSO	**2.444**	**1.5848**	**10**	**43.2007**	**0**
JAYA	**2.444**	**1.5848**	**10**	**43.2007**	**0**
RAO	**2.444**	**1.5850**	**10**	**42.5461**	**0**

V. CONCLUSION:

For the electrical power system networks to operate effectively, economically, and reliably, distributed generation (DG) must be placed and sized in the best possible way. The successful operation of electrical power system networks necessitates the optimal distribution of DG. These are the major issues for the safe functioning of power system networks: to decrease active power losses and improve the overall voltage profile. The optimal distribution of Distributed Generation using the Particle Swarm Optimization (PSO) Technique, JAYA, and RAO Algorithms has been compared in this paper. Distributed Generation (DG) type 1 is employed in this. The ideal losses in the IEEE-9 bus system are 2.9443 MW for JAYA, 2.9404 MW for PSO, and 2.8405 MW for the RAO algorithm. The maximum losses in the IEEE-14 bus system are likewise almost identical and are 3.4772 MW for PSO, 3.4783 MW for JAYA, and 3.4775 MW for RAO Algorithm. The optimum losses in the IEEE-30 bus system are likewise almost identical and are 1.5848 MW for PSO, 1.5848 MW for JAYA, and 1.5850 MW for RAO Algorithm. When compared to other algorithms, the RAO method improves the voltage profile significantly. With the use of the MATLAB Toolbox and MAT POWER 6.0, the PSO, JAYA, and RAO algorithms are used to allocate DG in the best possible way.

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