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Performance Evaluation of Optimization Techniques in DG Placement in a Standard Bus System

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***Abstract* - Integration of renewable Distributed Generation(DG) such as Photovoltaic(PV) system and wind turbine(WT) in distribution networks can be considered as brilliant and efficient solution to the growing demands. This paper introduces new effective hybrid PSOGSA optimization algorithm that deduce the optimal sitting and sizing of DG from the elected buses. The proposed scheme has been applied on 33-bus and 69-bus IEEE standard radial distribution systems. To insure the suggested approach validity, the evaluated results have been compared with particle Swarm Optimization algorithm.**

Keywords: Radial distribution system; Distributed Generation (DG) allocation; optimization algorithm PSOGSA; voltage stability; real power losses.

I. INTRODUCTION

The demand of electrical power is greater than the generation. The growth of demand triggers a need of more power generation. The demand of power is escalating in the world of electricity. The centralized power generating units use the conventional resources for generation purpose such as thermal, hydro power and nuclear system for electrical power generation. The distribution of electricity is the final stage in the delivery of electrical power to end users. An approach that employees of small scale power generation technologies that provides electric power at a site near to customers than the central generating stations is Distributed Generation.

DG is known as distribution generation which is placed near to the costumers to reduce the demand of electricity apart from the central generating stations. DG allows collection of energy from many sources which is naturally available and may cause less environmental impacts and improved the security of supply. The concept of DG has led to new considerations concerning the distribution network which have created a challenge and an opportunity for developing various novel technologies in power generation.

Concatenation of DG systems for the existing power systems influence Power Quality (PQ), Degrade system, Reliability and cause overvoltage and safety issues. Power Quality is defined as any deviation in an electrical power such as (voltage, current and frequency) that impacts the normal operation of electrical equipment's. PQ disturbance arisen either from the source side or the load side may lead to various operational issues such as malfunctions, failure of electrical equipment instability and so on. Power quality (PQ) events such as swag, swell, transient, harmonics, notch, fluctuation and flicker are the most common types of disturbances that occurring a power line degrade.

DG was previously used as an active power source but today with technological advancement it is available in many forms such as an active power source of supply and reactive power supply. In the first stage the loss sensitivity factor(LSF) was satisfied for determining the optimal placement of DG units to reduce the search space of optimization algorithm and then simulation annealing algorithm (SA) was proposed for optimal sizing. Many researchers concentrated on decreasing the system losses without taking in their considerations the cost of losses and DG's units installations with their maintenance.Although some researchers took these costs in their accounts but they worked on improving the voltage profile only without reducing system losses and costs insufficiently.

II. PROBLEM STATEMENT

In our daily life the electricity is needed for wide purpose and we can find power reliability in it and generation of power from the sources like coal power generating and other generating stations which may affect the man kind and transmitting this power to consumers with help of transmission line for long and short ranges based on consumers rating, to build the generating station required vast site and huge man power to construct the stations there should be continuous power supply from the stations and initial investment is high , if the consumer's rating couldn't be generated from the stations few industry prepare their own sources to run the industry. Failures of components can be seen and replacements is done wherever it is occurred.To overcome the problem of power reliability we use the following algorithms like PSO, GSA etc.,

III. METHODOLOGY

The PSO Algorithm is used to solve the problem. The Particle Swarm Optimisation(PSO) is a computational method that optimises a problem by iteratively trying to improve a candidate solution with regard to a given measure of quality. The Gravitational search algorithm (GSA) is a kind of swarm intelligence optimization algorithm based on gravitation. In this system we are implementing the hybrid PSOGSA Algorithm to deduce the optimal sitting and sizing of DG of the elected buses has been applied on 33-bus and 69-bus IEEE standard radial distribution systems. The hybrid PSOGSA Algorithm is proposed with the combination of PSO and GSA. The main idea is to integrate the ability of exploitation in PSO with the ability of exploration in GSA to synthesize both algorithms strength. This method is applied to optimize the sitting and sizing of DG placement by considering its Benchmark functions.

Steps for Methodology

- Literature survey: To study on various methods to improve the power quality and reliability on power system has been surveyed by referring various papers.
- Netwon Raphson method is used for load flow analysis.
- Praticle swarm Optimization(PSO) method is used for determination of sizing and sitting of DG plant, tested on 33 and 69 bus system.
- Then the combination of both PSOGSA used for determination of sizing and sitting of DG plant, tested on 33 and 69 bus system.

- Consider f(x)=-x^2+2x+11 where x ranges from -2 to +2 On substitution from -2,-1,0,1,2 then f(x) will be 11,12,11,14,11

Step 1:- Assuming n=4

Step 2:- x1= -1.5 , f(-1.5)= 5.75
x2=0 , f(0)= 11
x3=0.5 , f(0.5)=11.75
x4= 1.25 , f(1.25)=11.9375 (best value)

Step 3:- considering v1(0)=v2(0)=v3(0)=v4(0)=0

Step 4:- P-best of 1 particle = -1.25
P-best of 2 particle = 0
P-best of 3 particle = 0.5
P-best of 4 particle = 1.25

- VELOCITY

Vj(i)=Vj(i-1)+r1[Pbest(j)-xj(i-1)]+r2[Gbest-xj(i-1)]

j=1,2,3,4 and i= iteration count and G best =1.25 and P-best will be -1.5 and r1and r2 will be taken from 0-1.r1=0.3294 and r2=0.9342.

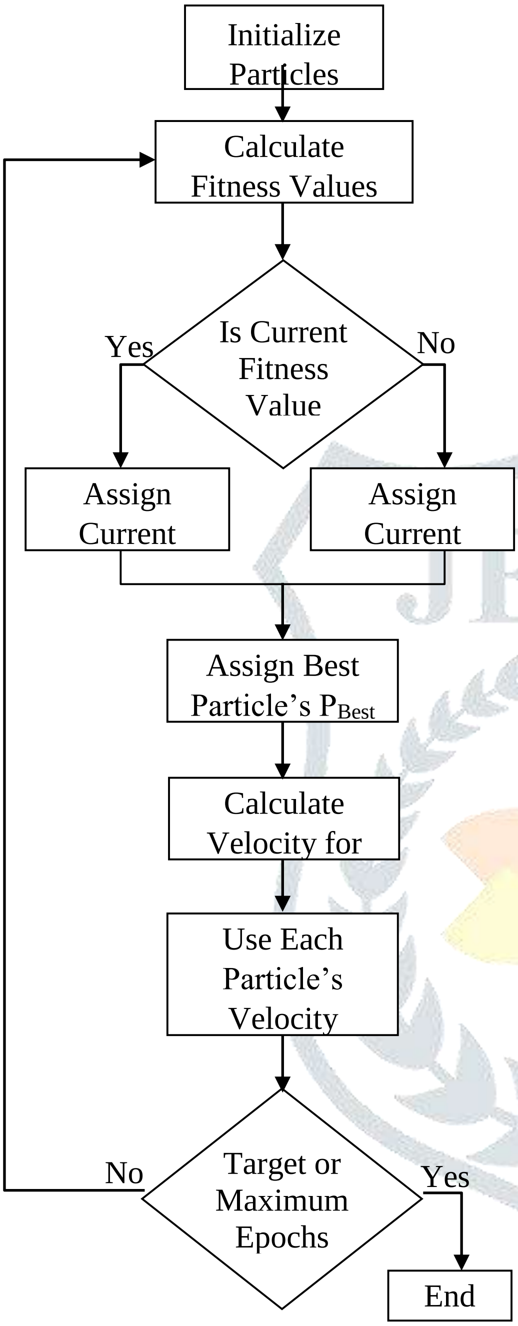
1st particle velocity = 2.6241
2nd particle velocity = 1.1927
3rd particle velocity = 0.7156
4th particle velocity = 0

- Then x1(1)= -1.5+ calculated velocity say 2.6241 then x1(1)= 1.1241,x2(1)=1.1927 , x3(1)=1.2156 & x4(1)=1.25
- substituting new x values for the fitness function then f(x1)=11.98 , f(x2)=11.9621 , f(x3)=11.9535 , f(x4)=11.9375
- The best fitness value is f(X1) and p-best will be 1.1124

IV. OPTIMIZATION TECHNIQUE

a. PSO ALGORITHM

PSO is a robust stochastic optimization technique based on the movement and intelligence of swarms. PSO applies the



concept of social interaction to problem solving. It was developed in 1995 by James Kennedy (social-psychologist) and Russell Eberhart (electrical engineer). It uses a number of agents (particles) that constitute a swarm moving around in the search space looking for the best solution. Each particle is treated as a point in a N-dimensional space which adjusts its "flying" according to its own flying experience as well as the flying experience of other particles.

STANDARD ALOGRITHM

The basic PSO algorithm can be described in vector notation as follows:

$$V_{k+1}=a \otimes V_K+b_1\otimes r_1\otimes(p_1-x_k)+b_2\otimes r_2\otimes(p_2-x_k) \quad (7.1)$$

$$X_{k+1}=c\otimes x_k+d\otimes V_{k+1}$$

The symbol ⊗ denotes element-by-element vector multiplication. At iteration k, the velocity V_k is updated based on its current value affected by a momentum factor 'a' and on a term which attracts the particle towards previously found best positions: its own previous best position 'p_1' and globally best position in the whole swarm 'p_2'. The strength of attraction is given by the coefficients 'b1' and 'b_2' . The particle position x_k is updated using its current value and the newly computed velocity v_{k+1} , affected by coefficients c and d, respectively. It is shown later that c and d can be set to unity without loss of generality. Randomness useful for good state space exploration is introduced via the vectors of random numbers r_1 and r_2 . They are usually selected as uniform random numbers in the range [0, 1]: $r_1, r_2 \in$ Uniform [0, 1].

It appears from equations that each dimension is updated independently from the others. The only link between

the dimensions of the problem space is introduced via the objective function, i.e., through the locations of the best positions found so far p_1 and p_2. Thus, without loss of generality, the algorithm description can be reduced for analysis purposes to the one-dimensional case:

$$V_{k+1}=aV_k+b_1r_1(p_1-x_k)+b_2r_2(p_2-x_k)$$
$$x_{k+1}=cx_k+dv_{k+1}$$

Figure 1. Flowchart of PSO

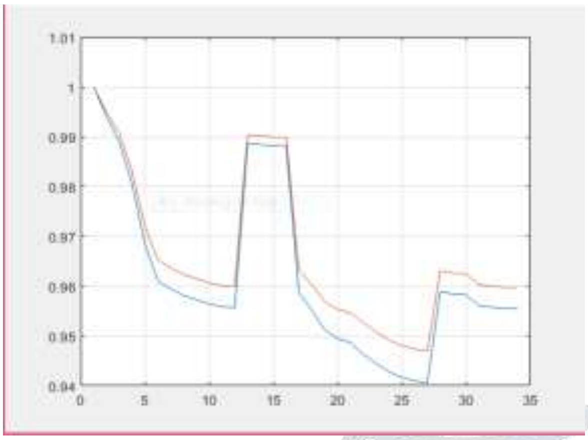


Figure 2. Result of PSO

b. PSOGSA TECHNIQUE

Hybrid PSOGSA approach is structured with the incorporation of PSO and GSA [9]. In PSO, Kennedy and Eberhart [10-11] produced PSO that is deemed as an evolutionary technique. The PSO was derived from social behavior of bird flocking. It employs a number of particles as candidate solutions that fly around in the search space to evaluate the best solution. To modify and update the position of each particle in PSO have to consider the current velocity and position, the distances of *pbest* and *gbest*. The mathematical model of PSO can be derived as follows [3]:

$$v_i^{t+1} = w * v_i^t + c_1 * r_1 [pbest_i^t - x_i^t] + c_2 * r_2 [gbest_i^t - x_i^t] \quad (22)$$

Positive constants c_1 and c_2 are the weighting factors, which are the acceleration constants responsible for varying the particle speed towards *pbest* and *gbest*, respectively. Variables r_1 and r_2 are two random numbers generated in the range [0, 1]. Eq. (23) provides the position update, depending on its previous position and its velocity, considering ¨t=1. In Eq. (22) consists of three parts, first part introduces exploration ability of PSO. Second and third parts are considered as private thinking and cooperation of particles respectively [9]. In (22), after calculating the velocities, the position of masses can be evaluated in (23). The iteration of process will continue updating the particles' position until achieving the PSO target.

In GSA, E. Rashedi et al. [12] implemented GSA as a novel heuristic optimization tool. Theory of this technique is deduced from Newton's gravitational force behaves is called ''action at a distance" [9, 12].

GSA can be considered as a combination of agents "elected solutions" whose have masses proportional to their value of fitness function. These masses are attracted between each other during generations. During the masses processes, the heavier masses that have a huge attraction force are possibly near the global optimum attract the other masses proportional to their distances.

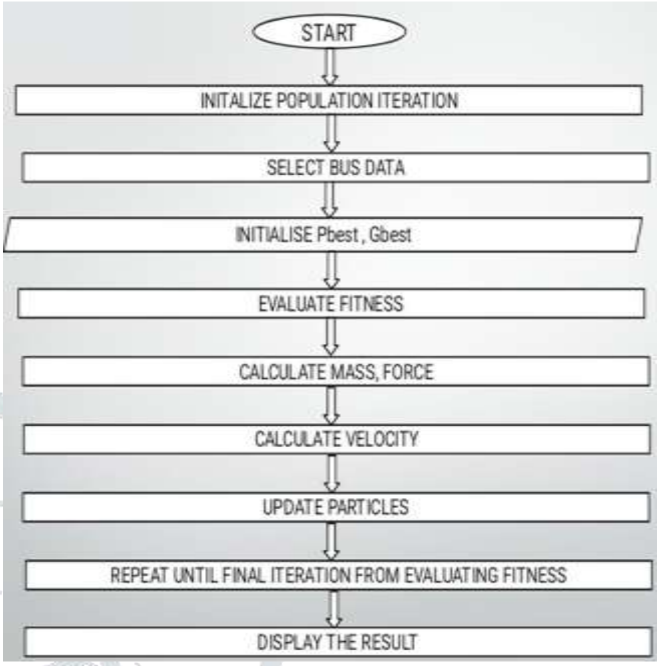
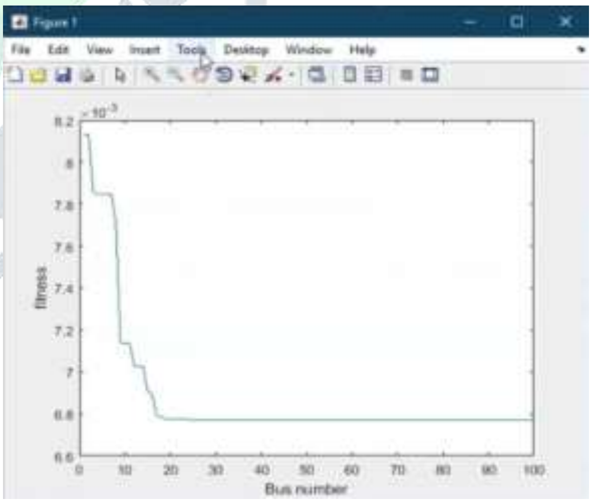


Figure 3. Flowchart of PSOGSA

Figure 4 . Graphical Results obtained when DG placed on 33 bus system for PSOGSA



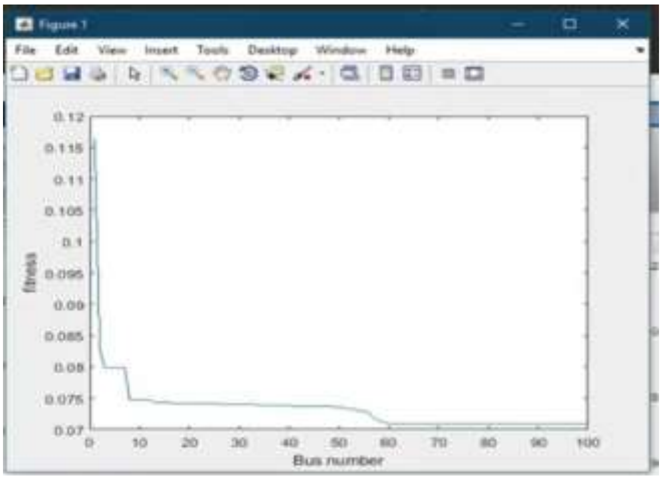


Figure 5. Graphical Result obtained when DG placed on 69 bus system

	Before Optimization	Proposed PSOGSA
Total Losses in KW	210.98	67.70
Optimal location & Size of DG's in MW	-	(24)1.0762MW (14)0.7432MW (30)1.044MW
Vworst(pu) bus	0.9038	0.99693(24,14,30)

Table 1. The Results of 39 bus system

	Before Optimization	Proposed PSOGSA
Total Losses in KW	224.98	70.95
Optimal Location & Size of DG's in MW	-	(49)0.82008MW (17)0.53091MW (61)1.7811MW
Vworst(pu) bus	0.9092	0.98817(49,17,61)

Table 2. The Results of 69 bus system

	Proposed PSO	Proposed PSOGSA
Total Losses in KW	165.3538 MW	67.70KW
Optimal location & Size of DG's in MW	(19)989.1016MW (22) 829.5634 MW (20) 262.5359 MW	(24)1.0762 MW (14)0.74327MW (30)1.0444MW
V_{PU} at worst	0.95 pu	0.99693 pu

Table 3 Comparision between PSO and PSOGSA

V. CONCLUSION

A novel strategy based on hybrid PSOGSA algorithm is proposed in this paper to find the optimal allocation and sizing of DGs in the radial distribution networks. The sensitivity factors are produced to reduce the search space of PSOGSA algorithm by estimating the most candidate buses for DG units' sitting. For power flow determinations, the Netwon raphson method is implemented. The proposed scheme PSOGSA has been tested on 33-bus and 69bus radial distribution systems. The results of the proposed algorithm have been compared with the PSO method to make sure the validation of the proposed approach.In PSOGSA will have the loses of 0.067 in 33 bus system and 0.0709 in 69 bus system. In PSOGSA the voltage will in between 1 pu to 0.98pu and in PSO the voltage lies between 1pu to 0.953 pu. The results illustrate that the proposed approach has a high accuracy and performance solution. It was clear that, the proposed scheme is capable of improving the voltage stability; minimizing the system losses and it says that PSOGSA is better than PSO.

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