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# Optimal allocation of wind based distributed generators in distribution system using Cuckoo Search Algorithm

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**Abstract**

In recent years the demand of electrical energy increases and limited availability of conventional generation sources, it is very important to use renewable energy resources in the power system network. Optimal location of renewable based distributed generators in distribution system is a challenging issue in recent years. In this paper an effective technique based on the cuckoo search algorithm is proposed to determine optimal allocation of wind based distributed generators in the distribution system. The objective is to reduce power loss of the distribution system. The proposed method is tested on IEEE 69 bus test system and the obtained results are compared with other methods for validation.


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*Keywords:* Distributed Genarators(DGs); Cuckoo Search Algorithm(CSA); Radial distribution system(RDS)

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## 1. Introduction

With the mounting demand of electrical energy, depleting fossil fuels and environmental concerns, it is essential to consider renewable based distributed generators (DGs) such as wind, solar and biomass based generation in the distribution system. Among these solar and wind based technologies are used because of its availability in nature. Generally power losses in the distribution system are high compared to the transmission systems because of high R/X ratio and radial nature [1]. So reduce these losses and improving operating efficiency the system, it is necessary to place these sources optimally in the distribution network. Proper allocation of these sources reduces the power losses, improving the voltage profile of the system. In the same manner improper allocation of these sources diminishes the distribution network performance, i.e. power losses and operating cost increases. So the optimal allocation of these sources in the distribution system for reducing power losses and improving the voltage profile is a challenging issue for researchers working in this field.

Various methods like mixed integer linear programming (MILP) [2], dynamic programming [3], analytical [4], improved analytical (IA) [5] methods are used to solve DG allocation problem for reducing power losses in the distribution system. But the above mentioned techniques are depending upon certain assumptions like continuity, differentiability and convexity. Also, these methods solve only linear optimization problems effectively. But the DG location and sizing problem is not a linear optimization problem, it is a discrete nonlinear optimization problem. So these techniques are not that much effective in solving optimal allocation problem in the distribution system. So it is necessary to consider search algorithms importance in solving above mentioned problem. Recently many search algorithms, i.e. Genetic Algorithm (GA) [6], Particle Swarm Optimization (PSO) [7], Combined Genetic and Particle Swarm Optimization [8], Multi Objective Particle Swarm Optimization (MOPSO) [9], Tabu Search(TS) [10] Simulated Annealing (SA) [11], artificial bee colony(ABC)[12] are used to solve DG allocation problem effectively with reduced power losses as an main objective. But the convergence time and operating efficiency of the system is high for these methods. In this paper an efficient technique based on the cuckoo search algorithm is presented for optimal allocation of wind based distributed generators for reducing real power loss of the distribution system. The developed method is implemented on IEEE 69 bus test system and the results are compared with other methods for validation.

The remaining sections of the paper are as follows: In section 2 problem formulation is explained, In section 3 wind turbine modeling is explained, In section 4 Cuckoo Search Algorithm (CSA) is used for optimal allocation of wind based DGs is explained, Results and Discussion explained in section5 followed by the conclusion is explained in Section 6.

## 2. Problem Formulation

### *2.1. Power flow equations*

A sample radial distribution system is shown in Fig.1. The current injected, branch current, voltage, real power losses are calculated from the direct approach of distribution load flow [13] and it is given in Eq.(1), Eq.(2), Eq.(3) , Eq.(4) and Eq.(5).

$$I_a = \left( \frac{P_a + jQ_a}{V_a} \right)^* \tag{1}$$

$$J_{a,a+1} = \mathrm{I}_{a+1} + I_{a+2} \tag{2}$$

$$J = [BIBC][I] \tag{3}$$

$$V_{a+1} = V_a - J_{a,a+1}(R_{a,a+1} + jX_{a,a+1}) \tag{4}$$