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Optimal Power Flow, Sizing and Location of Thermal Generating Units Using Meta – Heuristic Soft Computing Algorithms

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Abstract

This paper presents an approach on stochastically approximated optimal power flow (OPF) in thermal generation system. It also considers the optimal sizing and location of thermal generation units for finding the optimal generator with minimal losses in distributed environment. The proposed hybrid approach optimizes the power flow using stochastic approximation technique with Flower Pollination Algorithm (FPA). With OPF as a key objective, the system chooses the optimal location and sizing of distributed thermal generators using Krill Herd Algorithm (KH). Here, the objective function for FPA is concerned with minimal cost, emission and voltage stability index. Likewise, KH algorithm is concerned with minimal loss and installation of thermal generators. Proposed hybrid system that combines optimal power flow, sizing and location is compared with conventional techniques to prove its effectiveness. The comparative analysis of proposed hybrid approach is implemented over standard IEEE 30-bus and IEEE 57-bus distribution system. Simulation results proved that the meta-heuristic hybrid approach performs well when compared with available conventional techniques.

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***Keywords**:* Optimal Power Flow; Sizing and Location; Flower Pollination Algorithm; Krill Herd Algorithm; Fuel Cost; Emission; Voltage Stability Index.

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1. INTRODUCTION

In recent researches optimal power flow (OPF) is one of the essential factors for planning, operation and control factor for integrated and deregulated power industries like thermal distribution system [1]. Generally optimization is the process of selecting best solutions factor when limited number of resources is available in order to save energy, time, cost etc [2]. Distribution system is relatively smaller in size and provides power ranges from few kW to 100 MW since it is important for efficient utilization of available resources [8, 10]. Same like OPF problem optimal sizing and location of the thermal generation system is the important constraints. In the year of 2015 A.Y. Abdelaziz [3] stated that in distribution level distribution system subject to 13% ohmic losses due to misplacement of the distribution system it can be minimized by placing distribution system in appropriate position. For thermal distribution system it is necessary to maintain voltage stability with minimized reactive power loss [4]. To overcome OPF, optimal sizing and location numerous approaches are adopted like Particle Swan Optimization [5], Direct Search Algorithm [6], Teaching Learning Based Algorithm [7] and Evolutionary algorithm are developed for solving OPF and placing problem in thermal distribution system. Other than existing algorithm Krill Heard Algorithm (KHA) [2] provides effective convergence to particular solution.

In the last decade, several inspired algorithms are introduced and attempted for many engineering optimization problems. Some of the notable inspired algorithms are FPA (Flower Pollination Algorithm), krill herd algorithm, Particle Swan Optimization, Ant Colony Algorithm etc. By using existing algorithm as said above novel approach called stochastic approach which is recently evolved provides excellent solution to several challenges in thermal generation system [1]. Through stochastic approach uncertainties in thermal devices are optimized for efficient performance of the thermal system. In stochastic approach several random variables will be collected over time and consideration are taken to solve uncertainties in the thermal generation system [5]. While examining existing researches in the year of 2015, P.K Roy [9] analyzed about multi-objective OPF using KHA in various buses like IEEE 30-bus, IEEE 57-bus and IEEE 118-bus system. The OPF is examined for various parameters like fuel cost, voltage deviation minimization and voltage Stability improvisation. Obtained results of KHA are comparatively examined for various existing algorithm. From the comparative analyzes it is concluded that KHA outperforms rather than existing algorithms in terms of computation time, quality, convergence and robustness. Similarly in the year of 2014, Lenin [4] concentrates on minimizing economic dispatch problem using flower pollination algorithm. The FPA algorithm is tested with IEEE 30-bus system for minimizing real power loss and voltage stability. Simulation results demonstrate that FPA algorithm outperforms than existing algorithm in terms of voltage stability enhancement with voltage profile index. From the existing researches it is observed that KHA and FPA approach outperforms for solving OPF problem.

In this research proposed a stochastic approach for improving the performance of thermal generation system. This research is carried out by incorporating mete heuristic algorithm for solving OPF problem in thermal generation system for finding optimal size and location of the thermal generation system. For solving OPF in thermal generation system this research uses Flower Pollination Algorithm (FPA). By using FPA thermal generation system fuel cost, emission, loss and voltage stability index are comparatively analyzed. Since this research follows stochastic approach fuel cost and loss obtained from FPA algorithm are considered and utilized for finding optimal size and location of thermal generation system. For finding optimal sizing and location of the thermal generation system in this research uses Meta heuristic krill heard algorithm. Results of stochastic approach for finding OPF, size and location are obtained by stimulating Meta heuristic algorithm in IEEE 30-bus and IEEE 57-bus system. Results obtained by stochastic approach using Meta heuristic algorithm are comparatively examined with existing algorithm with both bus system.

2. Problem Formulation

The essential goal of OPF is to streamline the settings of control variables to meet certain destinations while fulfilling arrangement of uniformity and imbalance imperatives. The OPF issue can be scientifically communicated as takes after:

$$Minimize f(x,u) \tag{1}$$

Subject to,