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Power Transmission Optimization using Particle Swarm Optimization Method – A Review

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ABSTRACT: In a Power Distribution System (PDS) the most important operational criteria is Economic Load Dispatch (ELD). High cost of power-generation, increasing requirement of electric power by the market and limited availability of renewable energy resources is leading us to develop methodologies and systems that result in an economic generation and distribution power. The economic behaviour distribution of such a system under operational condition can be maintained by optimizing the difference between the demand and generated power and by minimizing the congestion loss. Under the varying load demand requirement condition the balanced sharing of the generated power through standard power distribution architecture is always an important issue to maintain the supply-demand criteria. There are many methods that offer their own positive and/or limited features to meet such criteria. This paper presents a review on Particle Swam Optimization (PSO) based approach to the optimized solution of power flow problem.

KEYWORDS: Distributed Generation (DG), ELD, PSO, Power Distribution System (PDS).

I. INTRODUCTION

The electric power generation is more than a century old technology but each element of the system contains high-tech solutions (power plant technology, generators, transformers, power electronic devices, power lines, Supervisory Control And Data Acquisition, etc.) The controlled elements are several millions so the system operation, stability, control, balance, optimization, settling is a really complex and distributed task. One of the concern areas in electrical power generation is distribution of power. The problem of ELD is to minimize the total cost of power generation (operational cost and including fuel consumption) from differently located power plants while satisfying the loads and losses in the power transmission system. The objective is to distribute the total loss and the total load demand among the generating plants while simultaneously minimizing generation costs and satisfying the operational Constraints.

Recently, global optimization is a motivational approach by swarm intelligence and evolutionary computation approaches have proven to be a potential uncertainty for the optimization of difficult EDPs. Particle swarm optimization (PSO) is a population-based algorithm driven by the simulation is one of the best solutions for ELD problem. In this context, this is the review paper proposes improved PSO approaches for solving EDPs that takes into account nonlinear generator features such as ramp-rate limits and prohibited operating zones in the power system operation..

Loss reduction and voltage profile improvement can do with the help of optimal placement and sizing of distributed generation units in distribution system. To obtain the maximum loss reduction and voltage profile improvement particle swarm optimization algorithm for DG units placement and sizing has been developed in terms of parameter selection. In order to achieve the required performance in DG resources and minimizing power loss, increase reliability, improve the voltage profile, and improve the power quality parameters of the electric grid, suitable placement and size required to provide for these DG units. Existing sources of Distributed generation in the system are photovoltaic cells, wind turbines, solar cell, fuel cells, fossil fuels, geothermal power, micro-gas turbines, etc. A simple heuristic approach for

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placement of DG with objective of minimization of loss using B loss coefficient, minimization of investments and operation costs is studied. Heuristic approach is advantages because of its simplicity to implement. However the drawback is that it does not always promise the best solution. The optimal or near optimal solutions of the optimization problem can be obtain by using meta-heuristic which is an iterative process. Meta-heuristic possibly be reflected to common algorithmic framework that can be applied to different optimization problems with hardly any modifications to make them adapted to a specific problem. To overcome the problems these methods are also being pile with other conventional optimization techniques.

In the distribution network sitting and sizing of Distributed generation can be done with the help of two methods and they are first method is traditional based such as optimal power flow (OPF), sensitive factor and repetitive load flows (reload flow) and the second method, the artificial intelligent (AI) is used to apply with DG placement and sizing like Ant Colony Algorithm (ACO), Genetic Algorithm (GA), Tabu Search (TS), Simulated Annealing (SA), Differential Evolution (DE) and Particle Swarm Optimization (PSO).

A. ***ANT COLONY OPTIMIZATION ALGORITHM:***

This method has an exceptional ability to find the shortest paths. It is a model to determine optimal location and size of Distributed generation in a distribution system.

B. ***GENETIC ALGORITHM (GA):***

It is one of the artificial intelligent-search based methods which gives solutions to optimization problems using techniques stimulated by natural evolution such as recombination, mutation, crossover, reproduction, selection etc. GA was also one of the methods used for sizing and placement of Distributed generation resourcefully in the system, with an aim to diminish power loss in different loading conditions.

C. ***TABU SEARCH (TS):***

Tabu Search technique is a Meta-Heuristic approach. The basic principle of TS is to track Local Search. It use memories called Tabu lists, which records the latest history of the search and this is key word that can be linked to Artificial Intelligence conceptions.

D. ***SIMULATED ANNEALING (SA):***

It is a meta-heuristic method for the worldwide optimization difficulties which traces a good estimate to the global optimum of a given function in a large search space. It is capable of integrating a probability function to examine the new solutions and using SA as optimization means optimal location, size of DG can be determined to reduce the losses, emission and survive in uncertainties

E. ***PARTICLE SWARM OPTIMIZATION (PSO):***

Particle Swarm Optimization is a very simple algorithm, iteratively solving, where a group of variables have their values adjusted closer to the member whose value is closest to the objective at any given point.PSO works on 3 basic parameters Target value, Global best (gBest) value defining which particle's data is currently closest to the Target, Stopping value indicating when the algorithm should stop.

II. RELATED WORK

A number of researchers and scholars proposed different optimization Techniques. In reference [1] the work focus on the comparative study of hybrid soft computing approaches in solving ELD problem and present a technical review of systems and approaches proposed by different research groups. This work introduces the individual methods to depict the differences in technique of the hybrid approaches over the basic soft computing methods with a brief description of the basic working principle and case studies of each hybrid approach. This work also highlights the challenges in the present problem and some of the most promising approaches. In reference [2] the main objective is to study meta-heuristic and heuristic approaches which are more feasible and simple solution in solving Distributed Generation siting and sizing problem. The Technical review of various techniques employed to state the issue of

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Distributed generation. This work introduced a hybrid of two or more approaches that can contribute a better option by integrating the benefits and discarding the shortcomings. That this work also highlights optimization techniques can be further explored and enhanced considering performance on various systems with their upgraded versions. Reference [3] had been described an electrical distribution system for use in power system reliability evaluation. This paper presents review on relationship between the distributors of electricity and the Regulator. It also mention whether the work has been done at the strategic level, i.e. if it concerns the planning of power distribution system based on reliability and uncertainty. Uncertainty of a result obtained reliability that a re-examination of relevant uncertain input data would be recommendable for a more precise quantification.

Reference [4] focused on studies such as UC, ED, OPF, Reactive power compensation, Load forecasting, FACTS, and so on based on PSO proposed model to obtain the optimal or quasi-optimal solutions in power system optimization to solve large scale non convex power system planning problems and present a technical review of systems and approaches proposed by different research groups. This work also compares the merits and demerits of the most promising approaches. Reference [5] presents a review that introduced FACTS Devices for power quality improvement, for efficient operation and continuous power supply to various load centres. Voltage sags, swells, harmonics etc are the various power quality problems that can be chandelled by FACTS devices that give better performance and good control of the parameters of power system by mitigating power quality problems. Some of FACT devices are IPFC, UPFC, and GUPFC. These devices gives more degrees of freedom, minimum errors and faster operation after optimization of various parameters of facts devices to improve and protect the parameters of power system and thus help to maintain power quality and better power flow. In reference [6] the work focus on the loss reduction and voltage profile improvement, this paper focuses on using an optimization methodology for identifying proper location and size of DG units. Solution's particle swarm optimization algorithm for DG units' placement and sizing has been developed in terms of parameter selection, to obtain the maximum loss reduction and voltage profile improvement. This work also comparing the proposed approach to other optimization algorithms, showed an improved performance and better results.

Reference [7] gives detailed theoretical analyses of the impact of large scale PV on transmission level is analyzed and controller is implemented to find the maximum penetration of solar photo voltaic (SPV) energy. This problem can be control by implementing two methodology constant load method and maximum loading method. The proposed approach is PSO based optimal control of large scale PV penetration allows us to utilize SPV power efficiently. In Reference [8] the main objective is to solve OPF problem considering the reactive power loss minimization. The approach used to solve the problem is Non-Linear Programming (NLP) – Interior Point (IP) Method, PSO Program has been applied on the various Test Bus Systems and sowing the results that the proposed PSO algorithm is reducing the power loss for all the test systems, The proposed algorithm has been applied to IEEE 14-bus, IEEE 30 Bus and 24 bus systems. This work also compares the Interior Point Method of Constrained Non-Linear Programming. In Reference [9] the works focus on the nonlinear optimization problem that can be solve by the proposed algorithm PSO. The proposed methodology determines control variable settings, such as the number of shunts to be switched, for real power loss minimization in the transmission system The proposed approach employs the PSO algorithm for the optimal setting of optimal power flow (OPF) based on loss minimization (LM) function and examined and tested on standard IEEE 14, IEEE 30 and IEEE 118 bus test systems. The obtained results are compared with the existing approaches.

Reference [10] focuses on the optimization of Reactive power in a PDS. Reactive power optimization is a nonlinear, multi-variable, multi-constrained programming problem, which makes the optimization process multifaceted. The problem of multi-objective optimization has been solved by converting it into a single objective optimization problem. To solve the problem approach used here is differential evolution based approach applied to multi-objective reactive power problem with real power loss and bus voltage deviations as competing objectives. The DE based approach has been implemented on IEEE 14-bus and IEEE-57 bus system, the same can be implemented for large size power systems as well. In Reference [11] the objective is to solve the problem of Reactive power optimization which is a complex combinatorial programming problem that reduces power loses and improves voltage profiles in a power system this can be overcome by multi objective particle swarm optimization and applied in reactive power optimization on IEEE-30 bus, Here the RPO problem has been formulated as a constrained multi-objective optimization problem by combining of two objective functions (real power loss and voltage profile improvement) linearly shows that the particle swarm optimization more effectively solve the reactive power optimization problem in power system. In Reference [12] works on optimal use of power. As seen the size of the power system increases, load may be varying and growing

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the demand for electric energy. The generators should share the total demand plus losses among themselves. Conventional optimization methods are not able to locate or identify the global optimum. To solve this problem a novel PSO based approach is presented in this paper to solve Optimal Power Flow problem. The algorithms were accurately and reliably converged to the global optimum solution in each case. The PSO-algorithm is also capable of producing more favorable voltage profile while still maintaining a competitive cost.

In Reference [13] the work focus on the utilization of power efficiently. In this paper detailed theoretical analyses of the impact of large scale PV is analyzed, large number of researches are going on in field of PV. Most of the study suggests the implementation of PV power stations at distribution level .In this paper the power system stability and security constraints are taken in to account for maximum penetration. Maximum penetration is achieved by adjusting grid parameters subjected to various power system stability and security constraints. Finally it can be concluded that PSO based optimal control of large scale PV penetration allows us to utilize SPV power efficiently It is found that PSO based optimization technique is much better to enable optimal allocation of SPVG in power system. In Reference [14] the main objective is to solve the power system restoration problem at the time of electrical failure. To solve this problem an approach is introduce in this paper is novel PSO and it is found by the results that the power system restoration of distribution system is obtain very efficiently by applying the PSO. In Reference [15] the work focus on two important optimization problems in power systems planning; namely, the OPF problem and the optimal capacitor placement and sizing (OCPS) problem. In this paper PSO has been selected as an optimization tool. With its discrete version being used to solve the OCPS problem such that the total power generation cost is minimized and the voltage profile is improved. This enabled improving the results compare with the existing approaches, where the capacitor sizes were treated as continuous variables and then rounded.

In Reference [16] the work focus on the requirement of electrical energy which is increased day by day, and to meet the demand generation of electrical energy has to be increased by taking cost in consideration. To meet the requirement renewable energy sources are introduced into the power system. Renewable energy sources are both inexhaustible and non-polluting they are the key to a sustainable energy supply system. This paper presents a new approach for load ability enhancement in power system with wind energy sources, without violating the system constraints. A PSO based algorithm has been used to minimize the system operating cost and from the results it is clear that load ability can be increased by penetrating wind to the system. In Reference [17] the aim is to consequent voltage instability in the power network which can be overcome by using FACTS devices. In this paper the optimal location and optimal sizing of static var compensator (SVC) is studied on the basis of PSO technique to minimize load voltage magnitude deviations and network losses using particle swarm optimization. PSO is one of the artificial intelligent search approaches which have the potential to solve such problems. For this study, SVC is chosen as the compensator device. Validation through the implementation on the IEEE 14 bus system shows that the PSO is found feasible to achieve the task. In Reference [18] works on optimal use of power. As seen the size of the power system increases, load may be varying and growing the demand for electric energy without increasing the cost of the network. This problem can be solve by using the FACTS devices This paper suggests a PSO based algorithm to determine the optimal location and setting of FACTS devices to improve the loading margin as well as voltage stability and small signal stability. The objective function is formulated as maximizing the load ability of the power system with load generation balance as equality constraint as well as voltage stability, generation limit and line limit constraints as inequality constraint. Results perform on the suggested approach show that the implementation of PSO has enhanced the transmission system load-ability with increased voltage profile.

In Reference [19] the aim is to find optimal placement of STATCOM for voltage profile improvement, loss reduction, and THD (Total Harmonic Distortion) reduction in distribution & transmission networks. This can be achieved by using PSO as a solving tool and use STATCOM as FACTS device Results show that the PSO is able to give the superlative solution with statistical significance and a great degree of convergence. In Reference [20] work focus on the combinatorial optimization problems which has a finite set of possible solution but it is not possible to check all solution every time. Many meta-heuristic algorithms have been devised and modified to solve these problems but the meta-heuristic approaches are not guaranteed to find the optimal solution since they evaluate only a subset of the feasible solutions. So to solve the problem Global Neighborhood Algorithm (GNA) is introduced in this paper. A set of random solutions are first generated from the global search space, and then the best solution will give the optimal value. After that, the algorithm will iterate, and in each iteration there will be two sets of generated solutions; one from the global search space and the other set of solutions will be generated from the neighborhood of the best solution In

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this paper GNA will be discussed and compared with the results of Genetic Algorithm (GA) as an example of another optimization method. In Reference [21] the main aim is to reduce the Real and Reactive Power losses in the power distribution system by DFIG placement and sizing using ordinary PSO which will improve the voltage profile .This paper also gives the comparative study of DFIG and HGAPSO with the objective to minimize the power losses. To fulfill the requirement the real and reactive power losses and voltage profile illustrate the DFIG need in the modern power system. In Reference [22], the work focus on Voltage instability and voltage collapse problem present in the power system. That can be overcome by using FACTS devices. A FACTS device in a power system improves the voltage stability, reduces the power loss and also improves the load ability of the system here we use Flexible AC Transmission System as a FACTS device. This is an alternating current transmission system incorporating power electronic-based and other static controllers to enhance controllability and increase power transfer capability. This paper also gives the comparative study of different FACTS devices results.

III. CONCLUSION AND FUTURE WORK

This paper presents a review on the Economic Load Dispatch problems and the solution methods which would describe by many scholars for Distributed Generation Planning (DGP) of various techniques employed to state the issue of Distributed generation siting and sizing. An Iterative approach (PSO) can contribute a better option by adjusting values closer to the member whose value is closest to the objective at any given point by using three parameters Target value, Global best (gBest) value and Stopping value. However optimization techniques can be further explored and enhanced considering performance on various systems with their upgraded versions.

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