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REVIEW OF OPTIMIZATION TECHNIQUES OF TRANSMISSION LINE BASED ON DSM

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Abstract – Power is generated in generating station, transmitted through transmission line and then distributed to consumers. Power system consists of three types of buses. They are generator bus, load bus and slack bus. Each bus is characterized by four parameters. They are bus voltage, phase angle, active power and reactive power. These buses are classified according to known parameters. Unknown parameters are found using load flow studies. In this paper load flow studies are done using Newton-Rap son method. Transmission line is characterized by resistance, inductance and capacitance. This will result in losses. These losses cannot be eliminated but can be reduced. Optimization is a mathematical tool to find the maximum or the minimum of a function subject to some constrains. Using lose function as objective function subjected to generator MW, transformer tapping, reactive power injection and controlled voltage as constrains, optimization technique can be used to minimize transmission losses. Using this we get optimal value for bus parameters such that transmission losses are minimum. In this paper Particle Swarm Optimization (PSO) is employed to solve optimal power flow problems. IEEE 30-bus power systems are used for testing the objective of this paper.

Keywords: Optimal Power Flow (OPF),Penalty factor, Newton-Raphson method, Power Loss Minimization, Particle Swarm Optimization (PSO),Gbest, Pbest

1. Introduction

Optimization problem was introduction by Carpentier in1962 .Optimal power flow is a nonlinear constrained and is used in optimization problems of power systems. Particle swarm optimal power flow is used to minimize the total fuel cost and to serve the load demand for a particular power system while maintaining minimal loss and the security of the system operation. The production costs of electrical power systems depend on the type of generating station. If losses are reduced generation can be reduced hence production coast can be reduced. So taking loss function as objective function optimization is done.

methodology for calculating the optimal generation capacity reserve and siting in power systems planning considering transmission network is proposed in [2]. A model and algorithms to assess a certain plan of composite generation and transmission system expansion are presented in [3]. The transmission has been integrated into integrated resource planning, with static model [4]. G. J. Anders proposed the generation expansion planning (GEP) model including the transmission lines with reliability constraints, modeled in both discrete and continuous case and solved using LP [5]. The GEP with power flow constraints is solved using Evolutionary Strategy approach [6]. There is an increasing concern on the role of transmission constraints on system reliability and economics in the current era of deregulation.

2 .Optimal power flows is a nonlinear

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2.1 Problem Formulation

The optimal power flow problem is a nonlinear optimization problem and it consists of a nonlinear objective function subjected to nonlinear constraints. The optimal power flow problem requires he solution of nonlinear equations, describing optimal and/or secure operation of power systems. The general optimal power flow problem can be expressed as

3. Metaheuristic Implementation to TC-GEP Problem

The important part in solving the combinatorial optimization problem using metaheuristic techniques is the formation of decision variables. The decision variables are formed based on a mapping procedure called 'Virtual Mapping Procedure (VMP)'. Since the metaheuristic techniques starts from the infeasible solution, the infeasible solutions are avoided in the subsequent iterations by using Penalty Function Approach (PFA).

3.1 Virtual Mapping Procedure (VMP)

To improve the effectiveness of the metaheuristic techniques, a novel mapping procedure called 'Virtual Mapping Procedure' is introduced to solve the TC-GEP problem [12].

3.2 Fitness function evaluation (Penalty Factor Approach -PFA)

The constrained problem is transformed into an unconstrained problem using PFA [12]. The objective function with PFA is given as fitness function F*(i)*.

3.3 Implementation of TC-GEP by the metaheuristic techniques

Metaheuristic can be defined as an iterated search procedure, which will guide the heuristics by combining different concepts for exploring and exploiting the solutions in the search space [8]. The classification is reported in [9]. The information about various metaheuristic techniques can be found in [10, 11]. The VMP and PFA are used to modify the problem and used in all the techniques.

3.3.1 Genetic Algorithm (GA)

The GA initializes the process by randomly selecting the populations of NP (number of parents) individuals from the VMP variable. The GA operators like crossover, mutation were applied on these parents, and the objective function and the fitness function values are calculated. Roulette wheel selection is used. Elitism is used, in which the best individuals of current iterations are accepted directly to next generation.

3.3.2 Differential Evolution (DE)

Unlike GA, (where the mutation takes place randomly on the parents), in DE, the mutation follows the procedure given

3.3.3 Evolutionary programming (EP)

EP is an optimization technique based on the mechanics of mutation, competition based selection. In EP, offspring are created, by mutation using the following:

3.3.5 Particle Swarm Optimization (PSO)

The synchronized movement of flocks of birds with out collision was the basic concept of PSO and was observed and studied by *Eberhart* [11,12]. The velocity of each agent is modified by adapting the following rule:

2.3 System Constraints

System constrains are generator, controlled voltage, reactive power injection from reactive power sources and transformer tapping. The objective is to minimize the power transmission loss function by optimizing the control variables within their limits. Hence there will be no violation on other quantities (e.g. MVA flow of transmission lines, load bus voltage magnitude, generator MVAR) occurs in normal system operating conditions. These are system constraints to be formed asequality and inequality constraints as follows

3.3.6 Tabu Search (TS)

In TS, first an initial random solution is generated. Then neighboring individuals are calculated by finding the neighboring capacities of the currently generated individuals. This reduces the size of neighbors. The best neighbor among the candidate list is moved to the *'Tabu list'* for *a priori* set number of generations.This will allow the TS to avoid trap in local minima.

3.3.7 Simulated Annealing (SA)

SA iteratively searches the neighbor by adding some random number with the current solution. The best solution is readily accepted. The worst solution is also accepted by comparing (31) with a random number (0, 1), which avoids trapping in local minima.

If value is high, then the P value will be nearly equal to zero. To avoid this, the fitness function value is scaled down which reduces the initial temperature. Since, no standard formula available for the cooling schedule, the temperature can be decreased linearly, logarithmically, or random reheating.

3.3.8 Hybrid Approach (HA)

In GA, as the populations are selected randomly, the infeasible combinations also get into the initial population. Due to this, the number of generations to achieve global minimum is increased. To produce the best/optimal solutions, HA is used. The performance of any metaheuristic can be improved by using HA approach.

HA, uses a 2-phase algorithm. In Phase-1, any one of the metaheuristic techniques (GA) is employed by using the IIPG. In phase-2, the solution space is narrowed down based on the basis of best solutions capacity and a direct search technique is applied. The phase-1 iterations stop, if there is no improvement in the objective function value, for *a priori* set number of generations. Then the phase-2 algorithm is applied.

In phase-2, the possible combination of same capacities and its neighboring capacities are evaluated and among them the least cost combination is selected to be the best solution. This avoidssome of the local minima.

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CONCLUSION

This paper proposed the metaheuristic techniques for transmission constrained least-cost generation expansion planning problem by considering OPF and the location of the generating units as additional constraints for a fixed transmission line system. To improve the effectiveness of the metaheuristic techniques, a novel mapping procedure called 'Virtual Mapping Procedure' is introduced. The results obtained by the metaheuristic techniques were compared in terms of their success rate, average number of function evaluated, average number of iterations to obtain the optimal solution and the error percentage. Among the metaheuristic techniques, DE, PSO and EP perform better. The application of HA, produces the optimal solution with a success rate of 100%.

5. Biography

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