A COMPARATIVE STUDY OF VARIOUS EVOLUTIONARY METHODS FOR OPTIMAL REACTIVE POWER DISPATCH

S.Pugazhenthi¹, R.Suresh², Dr.J.Baskaran³

¹PG scholar, Department of Electrical and Electronics Engineering, S.K.P. Engineering College, Tiruvannamalai, Tamil Nadu, India.

²Assistant Professor, Department of Electrical and Electronics Engineering, S.K.P. Engineering College, Tiruvannamalai, Tamil Nadu, India.

³Professor and Head, Department of Electrical and Electronics Engineering, Adhiparasakthi Engineering College, Melmaruvathur, Tamil Nadu, India.

ABSTRACT—Reactive power dispatch plays a significant role for secure and economic operation of power systems. The main purpose of optimal reactive power dispatch (ORPD) is to improve the voltage profile, to reduce losses, to improve voltage stability etc... This paper presents a brief literature survey of reactive power dispatch and also discusses a comparative study of various evolutionary computational techniques applied for reactive power dispatch. This paper gives an useful idea for researchers for further research and study so that it can apply in the various areas of power system.

Key words—Optimal Reactive Power Dispatch, Evolutionary Computational Techniques.

1. INTRODUCTION

Optimal reactive power dispatch has an important role in secure and economic operation of power systems. In power systems, basic objective of OPRD is to identify optimal setting of control variables which minimize the given objective function as either total transmission line loss, or ultimate value of total voltage deviations, or improvement of voltage stability index while satisfying the unit and system constraints. This system is accomplished by proper adjustment of reactive power variables like generator voltage magnitudes, transformer tap settings and switchable Volt Ampere Reactive (VAR) sources.

To solve the ORPD problems, the optimization methods are classified in to classical and heuristic optimization methods.

Classical optimization methods, such as gradient-based optimization algorithm, quadratic programming, interior point method and nonlinear programming.

Recently, due to the basic efficiency of interior point method, which offers fast convergence and convenience in handling inequality constraints in comparison with other methods, interior point method has been widely used to solve the ORPD problem of large scale power systems.

Most of the methods are based on the combination of the objective function and the constraints by Lagrange formulation, Kuhn Tucker condition, and gradient-based optimization algorithm and an applying sensitivity analysis [1].

In this paper, discusses an Evolutionary methods such as evolutionary programming, genetic algorithm, particle swarm optimization, harmony search algorithm, quasi-oppositional teaching learning based optimization, differential evolution, gravitational search algorithm, Big Bang-Big Crunch etc... have been recently proposed for solving the ORPD problem. These algorithms have recently found extensive applications in solving global optimization searching problems. Therefore, this paper proposes a brief literature survey and comparative study of above algorithms.

2. PROBLEM FORMULATION

Optimal reactive power dispatch problem can be solved as a single objective optimization problem as well as multi objective optimization.

2.1 Single Objective Optimization (SOO) Problem:

A single objective optimization problem is a problem in which only one objective function is considered at an instant. Mathematical representation of SOO is defined as follows:

Min./Max.  \( f(x) \)

Subject to  \( g_i(x) = 0 \) where \( i=1, 2, ..., i \)

\( h_j(x) = 0 \) where \( k=1, 2, ..., j \)

Where \( x= (x_1,x_2,\ldots,x_m) \) is a vector of \( n \) design decision variable.

\( g_i(x), h_j(x) = \) inequality and equality constraints

\( I = \) index for inequality constraints,

\( J = \) index for equality constraints,

“\( i \)” and “\( j \)”= number of inequality and equality constraints.

2.2 Multi Objective Optimization (MOO) Problem:

Multi objective optimization problem is defined as follows:

Min. /Max.  \( F(x) = [f_1(x), f_2(x), \ldots, f_k(x)] \)

Subject to  \( g_i(x) = 0 \) where \( i=1, 2, ..., i \)
hj(x) = 0  where k= 1,2,....j

Where [f1(x), f2(x), .......fk(x)] are the objective function

3. DESCRIPTION OF EVOLUTIONARY COMPUTATION TECHNIQUES

Q H Wu, Member, IEEE, J T Ma[2] was proposed the optimal reactive power dispatch is a global optimization problem of a noncontinuous, nonlinear function arising from large-scale industrial power systems. The conventional gradient-based optimization algorithms have been applied with a lot of mathematical assumptions, but not powerful enough to deal with this problem. The projected evolution approach developed especially to be coupled with power flow computation has been evaluated on IEEE 30-bus system. The EP method is able to undertake global search with a fast convergence rate and a feature of robust computation, and possesses an inherent capability for parallel processing. And also a great saving of active power has been obtained using the Evolutionary Programming (EP).

M. Varadarajan[3] was proposed differential evolutionary algorithm for optimal dispatch for reactive power and voltage control in power system operation study. The optimal settings of control variables such as generator voltages, tap positions of transformers and the number of shunt compensation devices to be switched for real power loss minimization in the transmission system are determined. The algorithm was tested on standard IEEE 14, 30, 57, and 118- bus systems and the results are compared with conventional method.

A. H. Khazali[4] Proposed harmony search algorithm for Optimal Reactive Power Dispatch (ORPD) problem. Determination of the universal or global optimum solution. Comparing the proposed algorithm with other two techniques simplified Genetic Algorithm (SGA) and Particle Swarm Optimization (PSO) shows the advantage of this algorithm in decreasing the transmission loss, to reduce voltage deviation and increasing the voltage stability index.

Barun Mandal[5], ORPD based Teaching Learning Based Optimization (TLBO) and Quasi-Oppositional Teaching Learning Based Optimization (QOTLBO) algorithms are proposed to minimize the total real power loss, to reduce voltage deviations, and improve the voltage stability index. The performance of the proposed algorithms are demonstrated through their evaluation on the IEEE 30-bus and IEEE 118- bus power systems. Therefore, it can finally be concluded that the convergence property as well as solutions quality of the proposed QOTLBO method is promising and encouraging for further research.

Binod Shaw, V. Mukherjee, S.P. Ghosal[6] was proposed, One recently developed meta-heuristic like OGSA has been successfully implemented to solve the ORPD problem of power systems and the economical as well as technical benefits arisen are presented in this paper. In this study, to minimize the active power loss, or that of Total Voltage Deviation (TVD), or improvement of VSI is individually optimized. The proposed Opposition-based gravitational search algorithm (OGSA) is tested on IEEE 30, 57, and 118- bus test systems to demonstrate its effectiveness. Finally, thus the proposed OGSA may be recommended as a very promising algorithm for solving several more other complex engineering optimization problems for the further researchers.

Rayudu Katuri, A. Jayalaxmi[7] Proposed genetic algorithm for reactive power optimization in the power system tends to maintain a good voltage profile by improving the voltage quality other than decreasing the real power loss in the system. Also increase the voltage stability margin. This case study is made on all the optimization variables mentioned and the effect on generators reactive power output is analyzed. The results obtained for the IEEE-24 bus power system had indicated that the Genetic Algorithm (GA) not only improves the voltage stability but also reduces the effect on generators for the Reactive Power.

Baskaran J, Palanisamy V[8] Proposed Hybrid approach method to deal with Optimal location of FACTS devices. Handling discrete and continuous variables and nonlinear and discontinuous constraints are explained in this paper. Results from applying PSO, GA, and DE on IEEE 30-bus system show the capability of PSO for solving this problem and robustness of PSO with respect of genetic algorithm and differential evolution.

S. Sakthivel[9] Proposed Big Bang-Big Crunch (BB-BC) algorithm is implemented to solve the multi-constrained optimal reactive power flow problem in a power system. This paper concentrate towards to decreasing the real power loss in transmission lines and the voltage deviation at the load buses by controlling the reactive power flow is an important task was obtained in this paper. BB-BC algorithm is tested on the standard IEEE-30 bus test system and the results are compared with other methods to prove the efficiency of the new algorithm. The results are quite encouraging and the algorithm is found to be efficient.

Masoud Farhoodnea[10] Proposed improved discrete firefly algorithm is an improved solution for optimal placement and sizing of active power conditioner to improve power quality in distribution system was obtained this paper. The Discrete Firefly Algorithm (DFA) is improved to solve the problem using a multi-objective function which considers enhancing the system voltage profile, and minimizing the total harmonic distortion (THD). The effectiveness of the proposed Improved Discrete Firefly Algorithm (IDFA) is validated on the radial IEEE 16 and 69-bus test systems. The results are compared with the DFA, GA and DPSO to prove the superior performance of the proposed improved discrete firefly algorithm (IDFA).
4 APPLIED TO OPTIMAL REACTIVE POWER .
SUMMARY OF VARIOUS EVOLUTIONARY
METHODS DISPATCH

Table 1: Comparison of Various Methods

<table>
<thead>
<tr>
<th>S.No</th>
<th>Reference No.</th>
<th>Objective Function</th>
<th>Solution Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Q H Wu, Member, IEEE, J T Ma[2]</td>
<td>Saving of Active Power</td>
<td>Evolutionary Programming</td>
</tr>
</tbody>
</table>

9. Masoud Farhoodnea[10] | Enhance System Voltage Profile, Minimize the THD and Total Investment Cost | Improved Discrete Firefly Algorithm |

CONCLUSION

The above discussion shows the different methods involved in solving the optimal reactive power dispatch problems. The Evolutionary computational techniques have been reported in literature for Optimal Reactive Power Dispatch (ORPD) problems. These techniques are easy to be applied, it does not depend on type and nature of the problem, but time consuming and more parameter tunings are required. It provides the near global optimum solution.

REFERENCES:


BIOGRAPHIES:

S. Pugazhenthi received the B.E. Degree in Electrical and Electronics Engineering from Anna University Chennai in 2013. He is currently pursuing his M.E. Degree in Power Systems Engineering at SKP Engineering College, Tiruvannamalai, Tamil Nadu, India. His interest areas are Power System optimization, Optimization techniques, Operational Planning and Control.

R. Suresh received the B.E. Degree in Electrical and Electronics Engineering from Madras University in 2003 and the M.E. Degree in Power systems engineering from Annamalai University, Chidambaram, India in 2007. He is currently pursuing his Ph.D., Degree in Electrical Engineering faculty from Anna University, Chennai, India. He is working as an Assistant Professor of Electrical and Electronics Engineering Department at SKP Engineering College, Tiruvannamalai, Tamil Nadu, India. His research areas of interest are Power System optimization, Optimization techniques, Operational Planning and Control.

Dr. J. Baskaran was born in 1976 in Tamilnadu, India. He received his B.E degree from Madras University, Chennai in 1997 and M.E Degree from Annamalai University, Chidambaram in 2006 and Ph.D from Anna University, Chennai in 2010. He has 14 years teaching and 4 years research experience. Now he is working as a professor and Head of EEE department in Adhiparasakthi Engineering College, Melmaruvathur, Tamilnadu, India. His research area of interest includes power electronics, optimization control in power system, FACTS, Distributed power system.