MULTI AREA ECONOMIC DISPATCH USING PARTICLE SWARM OPTIMIZATION TECHNIQUE

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DEDICATION

This thesis is dedicated to my wife, who have supported me with best kind of encouragement and comfort. This thesis also dedicated to my parents, who taught me that even the largest task can be accomplished if it is done one step at a time.

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ABSTRACT

Multi-area Economic Dispatch (MAED) is an important issue in power system operation and generation which the main aim is to achieve minimal cost. In previous paper, the consideration is only on single area economic dispatch. However, this cannot represent power generation as an overall on transmission network. Particle Swarm Optimization (PSO) is used to find optimum cost of generation by considering the constraints such as tie-line limit, area power balance and transmission line losses. In this paper, the algorithm with respect to predicted load demand is tested on a two area network with three set of test data consists of 4 Units, 6 Units and 40 Units system. The proposed methodology to solve MAED problem begins with finding range of area power demands for each area by incorporating the tie line limits. Area with cheaper fuel cost will be selected to export power to area with high demand. In order to design this algorithm, the assumption are no losses in tie-line and fix amount of power flow through the tie-line. Comparison were performed with respect to Genetic Algorithm (GA) and PSO for solving the MAED problem in practical power system. PSO has shown a better result than GA for all the three case studies.

ABSTRAK

Pengagihan Kuasa Secara Ekonomi Di Beberapa Kawasan (MAED) adalah isu penting dalam operasi dan penjanaan sistem kuasa di mana tujuan utamanya adalah untuk mencapai kos yang minimum. Dalam artikel dahulu, pertimbangan hanya dilakukan pada satu kawasan pengagihan kuasa secara ekonomi. Walau bagaimanapun, ini tidak dapat mewakili penjanaan kuasa sebagai keseluruhan pada rangkaian pengagihan. Pengoptimuman Swarm Partikel (PSO) digunakan untuk mencari kos penjanaan yang optimum dengan mempertimbangkan kekangan seperti talian had penghubung, keseimbangan kuasa kawasan dan kerugian dalam talian pengagihan. Dalam artikel ini, algoritma berkenaan dengan permintaan beban yang diramalkan akan diuji pada dua rangkaian kawasan dengan tiga set data ujian terdiri daripada sistem 4 Unit, 6 Unit dan 40 Unit. Metodologi yang dicadangkan untuk menyelesaikan masalah MAED bermula dengan mencari pelbagai permintaan kuasa kawasan untuk setiap kawasan dengan menggabungkan talian had penghubung. Kawasan dengan kos bahan api yang lebih murah akan dipilih untuk mengeksport kuasa ke kawasan dengan permintaan yang tinggi. Untuk merangka algoritma ini, andaian tidak ada kerugian dalam talian penghubung dan jumlah aliran kuasa melalui talian penghubung adalah tetap dan tidak berubah. Perbandingan dilakukan antara Algoritma Genetik (GA) dan PSO dalam menyelesaikan masalah MAED dalam sistem kuasa yang sebenar. PSO telah menunjukkan hasil yang lebih baik daripada GA untuk semua tiga kajian kes.

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LIST OF ABBREVIATIONS

ABCO	-	Artificial Bee Colony Optimization
AI	-	Artificial Intelligence
ANN	-	Artificial Neural Network
CED	-	Central Economic Dispatch
DE	-	Differential Evolution
ED	-	Economic Dispatch
EP	-	Evolutionary Programming
GA	-	Genetic Algorithm
HNN	-	Hopfield Neural Network
MAED	-	Multi Area Economic Dispatch
MFA-LF-DM	-	Modified Firefly Algorithm with Lezy Flights and Derived Mutation

LIST OF SYMBOLS

λ_S	-	Incremental cost of selling utility (RM/MWh)
λb	-	Decremental cost of selling utility (RM/MWh)
λc	-	Cost of the transaction (RM/MWh)
$Cij(Pgij)$	-	Generation cost of *ith* generation unit at *jth* area
P_D	-	Real power demand
P_L	-	Total transmission line losses
P_{Tjm}	-	Tie-line real power transfer from area *j* to area *m*
N_T	-	Number of tie-lines from *jth* area to *mth* area
B_{ij}, B_{0i}, B_{00}	-	Transmission line losses coefficient/ B-coefficient
vij	-	Velocity of each particle
Xij	-	Position of each particle
W	-	Inertia weight parameter
C_1, C_2	-	Acceleration constant

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CHAPTER 1

INTRODUCTION

1.1 Problem Background

Power system engineer has the responsibility of designing a secure, efficient and optimum generating system at lowest cost. Hence, a reliable cum economical energy generation plan is required. The electricity demand in the world is in increasing trend, the rise will cause more complex interconnection network. Therefore, lowering the cost of electrical generation is necessary to reduce the impact of continuous increasing price of energy. Economic dispatch will keep the fuel cost low and based on the demand.

Single area Economic Dispatch (ED) is one of the optimization problems in power system operation. Generators are well allocated to the load demands in most economical manner while satisfying physical and operational constraints in single area [1]. Multi Area Economic Dispatch (MAED) is an extra of economic dispatch. A few areas are interconnected by tie-line with each area having few generators. MAED is optimization problem that generates the minimal fuel cost in all areas by determining level of generation and power transfer between areas. It is also necessary to satisfy the constraints such as generator limits, power balance, tie-line limit and transmission line losses.

1.2 Statement of the Problem

In paper [2], PSO is used to solve economic dispatch problem and then comparison with respect to Evolutionary Programming (EP) technique is conducted. There is no direct comparison between PSO and GA. Based on the results, PSO has outperformed EP in the case of achieving lower optimal cost. However, this paper focused on voltage stability and the case study is different. In paper [3], PSO is capable of obtaining higher quality solution efficiently by comparison between PSO and GA but without consideration on multi-area problem. In [4], PSO has shown to have fastest computational time compared to other algorithm. Hence, PSO is feasible to be used in MAED with consideration of constraints to handle most of the cost function inclusive of non-convex characteristics.

1.3 Objectives of the Study

This study embarks on the followings objectives:

1. To develop the multi-area economic model considering tie-line limit, generator limit, transmission line losses and power balance as constraints.
2. To optimize the model using algorithm of Particle Swarm Optimization (PSO) using two area network with three different case studies.
3. To validate the solution quality and computation efficiency by analysing between PSO and GA in producing the generation cost.

1.4 Scope of the Study

This study is carried out by using the following aspects:

1. Proposed method to evaluate the convergence curve based on number of iteration as one of the benchmark in determining the solution quality.

2. Proposed method to consider duration of convergence time (Sec.) as one of the benchmark in determining the computational efficiency of the system.

3. Conduct the optimization of the model using Particle Swarm Optimization (PSO).

4. Conduct experiment using test data of four units, six units and forty units system and simulate in MATLAB R2013a.

5. Perform the simulation by applying the test data to PSO, after that repeat it using GA. The comparison of result for both algorithm is tabulated.

1.5 Report Outline

In this report, a total of four chapters are presented. First chapter introduce on the background of the problem and the objectives of this study. The limitation and scopes are also explained here. Chapter 2 will look into literature review and method approach of using PSO and other methods as well as approach that has been proposed by other researchers.

Further detailed explanation on the description of research flow activities, steps in solving MAED problem and implementation of MAED in chapter 3. In Chapter 4, result comparison of PSO and GA for all three case studies are discussed. Description of MAED method and also future works are also explained in this chapter. Lastly, it is the conclusion and appendixes.

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