



UNIVERSITI PUTRA MALAYSIA

***NETWORK RECONFIGURATION AND CONTROL FOR LOSS REDUCTION
USING GENETIC ALGORITHM***

MOHAMMED HASSAN IZZALDEEN JAWAD

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USING GENETIC ALGORITHM**

By

MOHAMMED HASSAN IZZALDEEN JAWAD

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirement for the Degree of Master of Science**

March 2010

DEDICATION

To my dear parents, that I owe them each moment of my life, particularly my dear brother Adnan for his affectionate caring



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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman : Dr. Wan Fatinhamamah Wan Ahmad

Faculty : Engineering

Power distribution networks typically have tie and sectionalizing switches whose states determine the topological configuration of the network. In this work a feeder reconfiguration algorithm is presented for the purpose of power loss reduction in distribution networks. The methodology developed a combined optimization technique. Also capacitor placement employing Genetic Algorithm is presented in achieving the proper arrangement of capacitor in a distribution network. The proposed algorithm has been implemented in technical MATLAB package and tested with two examples namely, 18- and 49-bus systems. All the data for 18-bus system test are taken from previous work, and all the data for 49-bus system test are taken from an existing Iraqi distribution network.

The network reconfiguration problem is formulated as single objective optimization problem with equality and inequality constraints. The proposed solution to this problem is based on a general combinatorial optimization algorithm known as Genetic Algorithm, and the load flow equations in distribution network. Two

methods of load flow solution with different accuracy are employed, i.e., simplified method, which uses the approximation of P and Q at the start of the implemented program, and fast-decoupled method, which gives an exact solution.

Standard size capacitors according to IEEE are used in the capacitor placement tests using Genetic Algorithm for 18-bus system where 7 capacitors are needed to ensure minimal total power losses to be obtained. While in the 49-bus system the existing 7 capacitors are rearrange using Genetic Algorithm in obtaining minimal total power losses. It is found that a better capacitor placement is obtained for the 49-bus system compared to its existing network in Iraq. Note that the 18-bus system is originally without any capacitor.

Two selection methods that are used in Genetic Algorithm are the roulette wheel and tournament selections. Tests have shown that the differences are demonstrated only in execution time to arrive the best fitness function of the Genetic Algorithm. Whereas the results obtained from both selection methods are similar to each other. Tests results show that Genetic Algorithm is a suitable algorithm as it is an optimization technique with, high accuracy, and it avoids local minimum by searching in several regions to arrive to the global optimum solution. Thus, the outcome of this study shows that an efficient technique in solving network reconfiguration problem for power loss reduction in the distribution network has been successfully found.

Abstrak tesis dipersembahkan kepada Senat bagi Universiti Putra Malaysia dalam pencapaian keperluan untuk Ijazah bagi Master Sains

**RANGKAIAN PENTATARAJAHAN SEMULA DAN PENGURANGAN
KEHILANGAN MENGGUNAKAN *GENETIC ALGORITHM***

Oleh

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Rangkaian pengagihan kuasa lazimnya mempunyai suis pengikat dan pembahagi yang mana status suis tersebut akan menentukan keadaan tatarajah rangkaian. Dalam kerja ini pembahagi algoritma pentatarajahan semula dibentangkan untuk tujuan pengurangan kehilangan kuasa dalam rangkaian pengagihan. Kaedah ini mewakili teknik gabungan pengoptimuman. Juga, penempatan kapasitor dengan menggunakan *Genetic Algorithm* dibentangkan bagi memerolehi susunan kapasitor terbaik dalam satu rangkaian pengagihan. Algoritma yang dicadangkan telah dilaksanakan dalam pakej teknikal MATLAB dan diuji dengan menggunakan dua contoh iaitu, sistem bas-18 dan 49. Semua data bagi ujian untuk sistem bas-18 diambil daripada kerja terdahulu, dan semua data bagi ujian untuk sistem bas-49 adalah daripada satu rangkaian pengagihan yang wujud di Iraq.

Masalah rangkaian pentatarajahan semula dirumuskan sebagai pengoptimuman satu objektif masalah dengan persamaan dan kekangan ketaksamaan. Cadangan penyelesaian untuk masalah ini adalah berdasarkan kombinasi algoritma pengoptimuman yang dikenali sebagai *Genetic Algorithm*, dan persamaan aliran beban dalam rangkaian pengagihan. Dua kaedah penyelesaian aliran beban dengan kejituan yang berbeza telah digunakan, iaitu kaedah *simplified*, yang menggunakan penghampiran bagi P dan Q pada permulaan pelaksanaan program dan kaedah *fast-decoupled*, yang memberikan satu penyelesaian tepat.

Saiz kapasitor yang piawai berdasarkan kepada IEEE telah digunakan dalam ujian penempatan kapasitor menggunakan *Genetic Algorithm* untuk sistem bas-18 di mana 7 kapasitor diperlukan untuk memastikan jhmlah pengurangan kehilangan kuasa adalah minimum. Sementara itu, 7 kapasitor yang terdapat dalam sistem bas-49 disusun semula menggunakan *Genetic Algorithm* bagi memperolehi jumlah pengurangan kehilangan kuasa adalah minimum. Adalah didapati bahawa penempatan kapasitor yang lebih baik diperoleht basi sistem bas-49 jika dibandingkan dengan sistem tersebut di Iraq. Ambil perhatian bahawa sistem bas-18 yang asal tidak mengandungi sebarang kapasitor.

Dua kaedah pemilihan yang dipilih untuk digunakan dalam *Genetic Algorithm* ialah *roulette wheel* dan *tournament*. Ujian telah menunjukkan bahawa perbezaan hanyalah pada masa perlakuan untuk menghampiri keadaan terbaik bagi fungsi *Genetic Algorithm*. Manakala keputusan yang diperolehi dari kedua-dua kaedah pemilihan adalah menyerupai satu sama lain. Ujian-ujian membuktikan bahawa *Genetic Algorithm*

adalah satu algoritma yang sesuai di mana ia adalah satu teknik pengoptimuman dengan kejituan tinggi, dan ia dapat menghindari minimum setempat dengan mencari dalam beberapa rantau untuk menghampiri penyelesaian global yang terbaik. Maka, hasil kajian ini telah menunjukkan bahawa satu teknik yang cekap dalam penyelesaian masalah pentatarajahan semula rangkaian bagi pengurangan kenilangan kuasa dalam rangkaian pengagihan telah berjaya ditemui.



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I certify that an Examination Committee met on 18 of March 2010 to conduct the final examination of Mohammed Hassan Izzaldeen Jawad on his of Master thesis entitled “Network Reconfiguration and Control of Reactive Power for Loss Reduction Using Genetic Algorithm” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree.

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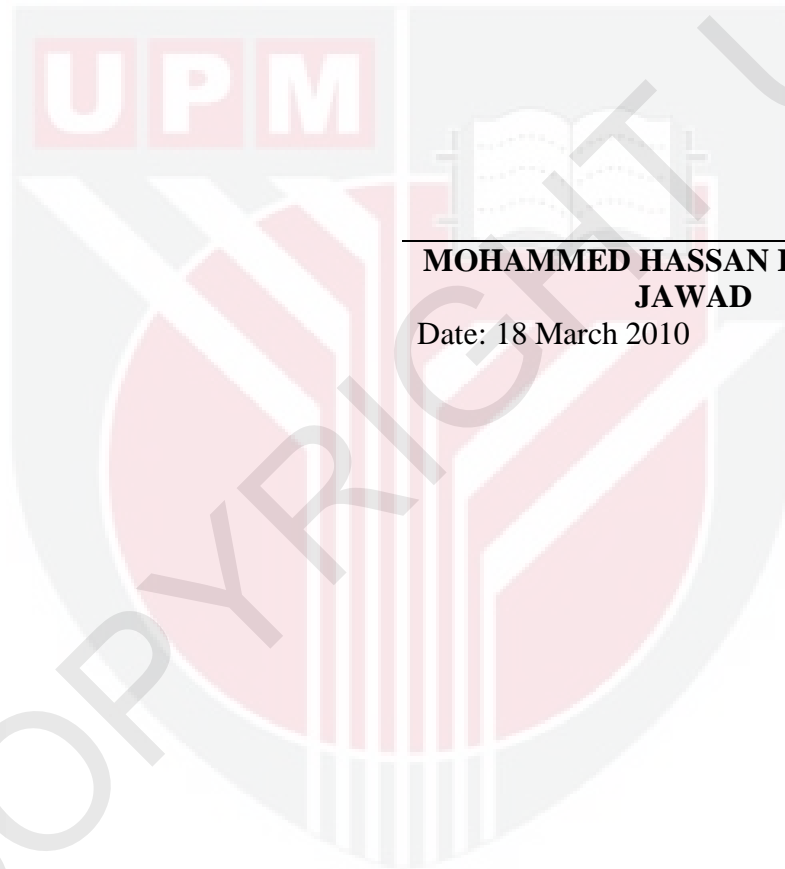
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DECLARATION

I hereby declare that the thesis is my original work except for quotations and citation which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Putra Malaysia or other institutions.



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Date: 18 March 2010

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