UNIVERSITI PUTRA MALAYSIA

GENETIC ALGORITHM BASED METHOD FOR OPTIMAL LOCATION PLACEMENT OF FLEXIBLE AC TRANSMISSION SYSTEM DEVICES FOR VOLTAGE PROFILE IMPROVEMENT

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By

MAHDI KARAMI

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

November 2011

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DEDICATION

It is my honor to dedicate this thesis to my dearest father ***Hassan Ali Karami*** *and my beloved mother* ***Zary Moradi Najar*** *due to their support, encouragement and motivation, those who gave me the love of studying and respect for education. I am indebted to them, so I hope I can make up their kindness by this dedication.*

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

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Chairman: Professor Norman Mariun, PhD, PEng

Faculty: Engineering

This thesis present a genetic algorithm based method for placement of FACTS devices for voltage profile improvement. The locations of controllers are determined based on two considerations which are increment of distance to collapse point and minimizing real power loss of system.

The Static Var Compensator (SVC), Thyristor Controlled Series Compensator (TCSC), Static Synchronous Compensator (STATCOM), Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC) are used in this thesis. These controllers can be connected in series, shunt or combination of both with the system.

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This study is focused on placement of mentioned FACTS devices in power system network which are the famous types of these controllers while most of works had been done with regards to one or limited types of FACTS controllers. The basic structure of FACTS devices and their configuration is described. A heuristic method known as genetic algorithm is used to seek the optimum location and setting of these controllers where there are some works related to this case using various techniques. The genetic algorithm technique is explained and the real number representation of genetic algorithm is modeled. Most of the previous close studies have been performed to optimize two parameters i.e. location and rated value of each device only, while all the possible control parameters of each device including its location are optimized simultaneously in this study.

The IEEE 14-bus, 57-bus and 118-bus test systems are utilized during this research to verify the recommended method. The modeling of power systems, FACTS devices and genetic algorithms are performed through MATLAB/PSAT simulation. The power flow analysis and continuation power flow analysis are employed to verify the performance of systems and to determine the collapse point of systems respectively. The results achieved from the simulations manifestly proved that the proposed method is an effective approach for placement of various types of FACTS controllers considering different problems in power system.

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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

KAEDAH CARA ALGORITMA SEMULAJADI BAGI PENENTUAN KAWASAN OPTIMAL PERALATAN FACTS UNTUK PENAMBAHBAIKAN PROFIL VOLTAN

Oleh

MAHDI KARAMI

November 2011

Pengerusi: Profesor Norman Mariun, PhD, PEng

Fakulti: Kejuruteraan

Kaedah cara algoritma semulajadi bagi penentuan kawasan peralatan FACTS untuk penambahbaikan profil voltan digunakan dalam tesis ini. Penempatan pengawal ditentu berdasarkan di atas dua pertimbangan dimana menambah jarak dari keruntuhan dan mengurangkan kehilangan kuasa sebenar sistem.

Pemampas var statik (SVC), pemampas thyristor dikawal bersiri (TCSC), pemampas segerak statik (STATCOM), pemampas segerak bersiri statik (SSSC) dan pengawal aliran kuasa disatukan (UPFC) digunakan dalam tesis ini. Kesemua kawalan ini boleh dihubungkan secara bersiri, menyimpang atau gabungan kedua-duanya dengan sistem.

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Kajian ini menfokus kepada penempatan optimum bagi peralatan FACTS yang disebut diatas dalam rangkaian sistem kuasa dimana adalah jenis yang popular bagi kawalan manakala bagi kebanyakan tugas telah dibuat berdasarkan kepada satu kawalan FACTS atau terhad. Struktur asas bagi peralatan FACTS dan konfigurasi telah dijelaskan. Kaedah heuristic dikenali sebagai genetic algorithm digunakan untuk mencari penempatan optimum dan menyediakan pengawal ini dimana ada sebahagian tugas yang berhubung kait dengan kes ini menggunakan teknik yang berbeza. Teknik genetic algorithm telah dijelaskan dan nombor sebenar bagi mewakili algoritma semulajadi di modelkan. Kebanyakkan kajian yang serupa sebelum ini, telah dilaksanakan bagi mengoptimum dua parameter contohnya kawasan dan kadar nilai bagi setiap peralatan hanya semasa kemungkinan kawalan parameter bagi setiap alatan termasuk tempatnya dioptimum dengan serentak dalam kajian ini.

Sistem ujian IEEE 14-bus, 57-bus dan 118-bus digunakan semasa kajian ini bagi mengesahkan langkah yang dicadangkan. Permodelan sistem kuasa, peralatan FACTS dan genetic algorithm telah digunakan melalui penyelakuan MATLAB/PSAT. Analisis kuasa aliran dan analisis aliran penerusan kuasa digunakan bagi mengesahkan pelaksanaan prestasi sistem dan menentukan titik keruntuhan sistem. Hasil diperolehi daripada penyelakuan dengan jelas membuktikan bahawa langkah yang dicadangkan adalah pendekatan yang efektif untuk menggantikan pelbagai jenis pengawal FACTS dengan dipertimbangkan masalah berbeza dalam sistem kuasa.

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I certify that a Thesis Examination Committee has met on 11 November 2011 to conduct the final examination of Mahdi Karami on his thesis entitled "Genetic Algorithm Based Method for Optimal Location Placement of Flexible AC Transmission System Devices for Voltage Profile Improvement" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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DECLARATION

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

Mahdi Karami

Date: 11 November 2011

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