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PERFORMANCE IMPROVEMENT THROUGH OPTIMAL LOCATION AND SIZING OF DISTRIBUTED GENERATION

ZUHAILA MAT YASIN

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Zuhaila binti Mat Yasin
Student ID. No.	:	2009255914
Programme	:	Doctor of Philosophy in Electrical Engineering (EE990)
Faculty	:	Electrical Engineering
Thesis Title	:	Performance Improvement through Optimal Location and Sizing of Distributed Generation
Signature of Student	:	....
Date	:	September 2014

ABSTRACT

This thesis presents a new technique to determine the optimal locations and sizing of multiple DG units in a distribution system based on the concepts and principles of quantum mechanics in the Evolutionary Programming (EP) namely Quantum-Inspired Evolutionary Programming (QIEP). The concept of Quantum-Inspired is implemented according to three levels namely quantum individuals, quantum groups and quantum global in order to accelerate the convergence time of the EP. To enhance the robustness of the algorithm, the QIEP technique is constructed based on multiobjective model in which the multiobjective functions consist of reducing power losses, increasing maximum loadability and cost minimisation. All simulations in this study were carried out using IEEE 69-bus distribution test system and 141-bus distribution test system. The performances of the multiobjective QIEP optimisation technique were compared with those obtained from EP optimisation technique in terms of fitness values, consistency and computation time. In addition, the comparison also has been made between single objective and multiobjective optimisation. On top of that, the multiobjective QIEP is also applied to determine the optimal undervoltage load shedding (UVLS) in various loading conditions according to load profile with and without DG. From the analysis, it was found that the multiobjective QIEP had yielded better optimal solutions and more consistent with faster convergence time as compared to other techniques. In order to ensure that the proposed technique is suitable for on-line application, a novel intelligent based technique is presented to predict the optimal output of DG and optimal undervoltage load shedding at various loading conditions. At this stage, a classical Artificial Neural Network (ANN) is developed using systematic training and testing procedures. Next, a novel hybrid Artificial Neural Network - Quantum-Inspired Evolutionary Programming (QIEP-ANN) is developed for comparison. Later, a Least-Squares Support Vector Machine (LS-SVM) model was developed using cross-validation technique. Finally, a novel hybrid Quantum-Inspired Evolutionary Programming - Least-Squares Support Vector Machine (QIEP-SVM) was presented. The results showed that the QIEP-SVM model had shown better prediction performance as compared to classical ANN, LS-SVM and QIEP-ANN.

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CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

Electrical power systems have been traditionally designed for taking energy from high voltage levels and distributing it to lower voltage level networks. There are large generation units connected to distribution systems via transmission lines. In transmission systems there is a bulk transport of electricity, with central coordination of controls (modulating outputs of generators). Demands connected to distribution systems are usually passive and uncontrollable. Distribution systems are also passive and with radial operation in the lower levels of voltage. They are designed to accept power transmission systems and distribute to customers, generally with unidirectional flows although some of them are interconnected [1].

The increase in demand has posed a challenging task to power system engineers in maintaining a reliable and secure system economically. Limited area and slow progress in network expansion has also caused the formation of areas with high load densities. During the peak load, the load current from the sources increases and this condition may increase the voltage drop and the system losses. With long transmission lines in rural electrical networks, the network performance decreased due to voltage drop and high distribution losses along the lines. Therefore, distribution utilities are would strengthen and expand their networks with limited source from the grid and also capital. With this regards, changes in economic and commercial environment of power system design and operation have necessitated the need to consider active distribution network by incorporating Distributed Generation (DG) [2,3].