
بسم الله الرحمن الرحيم

AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Electrical Power and Machines Engineering

Microgrid performance for flexible power system operation

Ph.D. Thesis

By Eng. Dina Ahmed Zaki Rostom

Submitted in partial fulfillment of the Requirements for the Ph.D Degree in Electrical Engineering

Supervised By

Prof. Dr. Al Moataz Youssef Abdel Aziz

Professor - Electrical Power and Machines Dept.

Faculty of Engineering, Ain Shams University.

Prof. Dr. Hany Mohamed Hasanien

Professor - Electrical Power and Machines Department

Faculty of Engineering, Ain Shams University

Prof. Dr. Noha Hany El Amary
Professor-Electrical and Control Engineering Department
Faculty of Engineering, Arab Academy for Science, Technology, and Maritime Transport.

Approval Sheet

For The thesis:

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Name Signature

Prof. Dr. Al Moataz Youssef Abdel Aziz

Prof. Dr. Hany Mohamed Hasanien

Prof. Dr. Noha Hany El Amary

Date: / / 2020

Examiners Committee

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Name, title and affiliation Signature

Prof. Dr. Abdel Ghani Mohammed Abdel Ghani

Electrical Power and Machines Department
Faculty of Engineering
Helwan University

1. **Prof. Dr. Tarek Saad Abdel Salam**
   Electrical Power and Machines Department
   Faculty of Engineering
   Ain Shams University

2. **Prof. Dr. Al Moataz Youssef Abdel Aziz**
   Electrical Power and Machines Department
   Faculty of Engineering
   Ain Shams University

3. **Prof. Dr. Hany Mohamed Hasanien**
   Electrical Power and Machines Department
   Faculty of Engineering
   Ain Shams University

Statement

This thesis is submitted to Ain Shams University in partial fulfillment of the requirements for Ph.D degree in Electrical Engineering.

The included work in this thesis has been carried out by the author at the Electrical Power and Machines Department, Faculty of Engineering, Ain Shams University. No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

Name: Dina Ahmed Zaki Rostom

Signature:

Date: / / 2020

To

My mother’s soul, my family, and friends.

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ABSTRACT

Decentralized Energy Generation Systems (DEGs) and microgrids achieve their vital role in power systems due to their practical and cost effectiveness advantages.

Nowadays, metaheuristic and adaptive techniques used in DEGs and microgrids performance enhancement are facing fast and incredible improvements.

This thesis illustrates new optimization and adaptive applications of various methods to improve the DEGs and Microgrid performance.

In this thesis, an inverter-based DEG and microgrids systems are used. A vector cascaded control method is utilized as an inverter control strategy, which depends on the Proportional plus Integral (PI) controller.

The PI controller parameters are optimized using many optimization techniques such as the Evaporation Rate based Water Cycle Algorithm (ER-WCA), Crow Search Algorithm (CSA), and Flower Pollination Algorithm (FPA). The optimization problem target and constraint functions are created by the Response Surface Methodology (RSM). The MINITAB program is used for extracting these equations.

Also, Artificial Neural Network (ANN) is applied in this thesis with the purpose of online biasing of the PI controller parameters.

Finally, adaptive PI controller based on Widrow Hoff adaptation technique is used to enhance the performance of the microgrid.

The validation of the suggested control techniques is checked by utilizing the simulation outcomes, which are carried out by PSCAD/EMTDC software. The previous outcomes are tested under various working settings as an example 1) system

conversion from network connected mode to stand alone one, 2) system exposure to various faults in the stand alone mode, and 3) system load variation exposure. The adequacy of the suggested controller is validated by evaluating its outcomes with that utilizing other conventional techniques such as Genetic Algorithm (GA). The MATLAB enviroment is utilized for the optimization process simulation .

Throughout the thesis it was noticed that utilizing new metaheuristic and adaptation methodologies have great impacts on the DEGs and microgrids performance.

Keywords:

Adaptive PI controllers, Artificial Neural Networks (ANN), Crow search algorithm (CSA), Decentralized energy generation Systems (DEG), Evaporation Rate Water Cycle Algorithm (ERWCA), Flower Pollination Algorithm (FPA), Genetic Algorithms (GA), Microgrid, Optimization methods, Power system control, PSCAD/EMTDC software, Response Surface Methodology (RSM), Widrow Hoff adaptation technique .

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