Ain Shams University
Faculty of Engineering
Electrical Power and Machines Department

Performance Enhancement of Active Distribution Networks

M.Sc. Thesis
By

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Submitted in partial fulfillment of the requirements of the degree of M.Sc. in
Electrical Engineering

Supervised by:
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Cairo, 2018

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Thesis title: Performance Enhancement of Active Distribution Networks

Degree: Submitted in partial fulfillment of the requirements for the M.Sc. degree in electrical engineering.

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STATEMENT

This Thesis is submitted to Ain Shams University in partial fulfillment of the requirements of Master of Science degree in Electrical Engineering.

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

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ABSTRACT

The demand for clean energy is growing day by day which has led to the increase in the penetration of renewable energy resources in distribution networks. There are serval types of renewable energy resources such as photovoltaic systems and wind turbines. Despite their benefits, integrating renewable energy resources into conventional distribution networks might cause some operational problems. These problems include harmonic distortion, protection coordination issues, and voltage regulation problems.

This thesis focuses on the voltage regulation of distribution networks in the presence of renewable energy resources. The thesis presents a distributed control strategy based on expert system rule using multi-agent system to coordinate between the available resources to enhance the voltage profile of the system. The strategy attempts to maximize the use of renewable based distributed generators while minimizing the operation of the on-load tap changer. The proposed strategy mitigates undervoltage violation in Feeders by utilizing the available reactive power from distributed generators at each Feeder as a first step. If this action is not enough, then the strategy aims to operate the on-load tap changer to solve the problem. In case of overvoltages, the strategy attempts to curtail the active power for some distributed generators if the reactive power is not sufficient to solve the problem. In this case, the remaining capacity of the distributed generators which participated in the power curtailment can be used to inject more reactive power. As a final stage, the on-load tap changer can be used to mitigate the overvoltage problem.

The proposed strategy is applied on networks with single Feeders and networks with multiple Feeders. Several case studies are simulated to show the effectiveness and robustness of the proposed strategy. The results show the ability of the coordination strategy to keep the voltage within acceptable limits under different operating conditions. Moreover, the stress on the taps of the on-load tap changer is relieved by avoiding unnecessary tap moves. Furthermore, the strategy avoids unnecessary active power curtailment through absorption of the available reactive power in distributed generators before curtailing any active power from distributed generators.

Keywords: Decentralized Control, Distributed Generator (DG),Multi-Agent System (MAS), On-Load Tap Changer (OLTC).

ACKNOWLEDGEMENT

I thank God, for wisdom and knowledge that He has blessed me. You made me strong. You gave me reasons to go and make the best out of me.

I would like to thank my supervisors: Prof. Dr. Metwally EL-Sharkawy and Dr. Walid Omran for their continuous guidance, support, and encouragement throughout my research study. They have been wonderful advisors to me and have made major influence in my academic life. I could not possibly list all that I have learned from them.

I am grateful for my parents, my wife and my brother, who helped me through all thesis. Thank you for supporting me in every way.

Mohamed Mohamed Ibrahim

Cairo, 2018

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