



Ain Shams University
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Performance Enhancement of Active Distribution Networks

M.Sc. Thesis
By

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degree of M.Sc. 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 several 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).

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