بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

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MONA MAGHRABY

Ain Shams University
Faculty of Engineering
Electrical power and Machines Dept.

PERFORMANCE ENHANCEMENT OF VARIABLE SPEED WIND ENERGY CONVERSION SYSTEM

Master Thesis
By

Eng. Mina Nabil Amin
Submitted in partial fulfillment of the Requirements for the Master Degree in Electrical Engineering

Supervised By

Prof. Dr. Almoataz Youssef Abdelaziz
Professor - Electrical Power and Machines Department
Faculty of Engineering, Ain Shams University

Prof. Dr. Hany Mohamed Hasanien
Professor - Electrical Power and Machines Department
Faculty of Engineering, Ain Shams University

Approval Sheet

For The thesis:

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Approved by

Name	Signature
Prof. Dr. Almoataz Youssef Abdelaziz	
Prof. Dr. Hany Mohamed Hasanien	

Date: / /

Examiners Committee

The thesis:

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Name, title and affiliation	Signature
1. Prof. Dr. Mohamed Ibrahim Elsayed	
2. Prof. Dr. Ahmed Abd Elstar Abd El fatah	
3. Prof. Dr. Almoataz Youssef Abdelaziz	
4. Prof. Dr. Hany Mohamed Hasanien	

Statement

This thesis is submitted to Ain Shams University in partial fulfillment of the requirements for Master 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 : Mina Nabil Amin
Signature :
Date : / / 2020

To

My wife, my brothers, my sister and their families.

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ABSTRACT

As a result of the world consciousness about environmental issues and to decrease the nuclear power demand, wind power becomes a competitive energy source that rivals the conventional power sources. However, the interconnection of the variable speed wind generator system (VSWG) with the network suffers from a lot of technical challenges, in terms of power quality and availability.

The variable-speed wind turbine (VSWT) generator systems have various merits that make them more prevalent in wind energy production. Some of these features are its capability to control, lower quantities of ripples, and higher power density compared to the fixed. There are various types of these machines used in the VSWT, Such as the permanent-magnet synchronous generator (PMSG). Which is featured by gearless construction, higher efficiency, small size, high reliability, and self-excitation.

The interconnection of the VSWT-PMSG and the electrical network is carried out by utilizing the fully rated frequency converter (FC). The FC composes of generator- and grid- side converters with an intermediate DC link capacitor (C_{DC}). The generator-side converter (GSC) has the responsibility to extract the maximum power from the wind to the grid at a unity power factor. The grid-side inverter (GSI) is applied to control the DC-link voltage and the terminal voltage as well, at a desired value adjusted by the operator. The C_{DC} is protected by an over-voltage protection scheme (OVPS). The cascaded control scheme is utilized to control both GSI and the GSC. This control strategy can utilize various types of controllers such as proportional-integral-derivative (PID), proportional-integral (PI), and fuzzy

logic controller (FLC). The PD and PID are not more attractive to be used in the industry due to the demerits of derivative control action, where it amplifies the input frequency of any harmonics to the system, and to avoid this problem; a designed filter should be used. Therefore, PI is commonly used. The main feature of the PI controllers is their wide stable responses. However, these controllers have a high sensitivity to variation of parameters and system non-linearity.

This thesis presents different control strategies to enhance the transient stability of a grid-connected wind generator system. A grasshopper optimization algorithm (GOA)-based PI controller, a hybrid particle swarm with a gravitational search algorithm (PSO-GSA)-based PI controller, and a GOA-based fuzzy logic controller (FLC). For achieving practical responses, real wind speed data extracted from the Zafarana wind farm in Egypt utilized in this study. The viability of the proposed control techniques compared with that achieved utilizing Newton-Raphson (NR) and genetic algorithm based-PI controller, considering severe grid disturbances are checked. The feasibility of the proposed control approaches is validated by the simulation study, which accomplished by using the MATLAB/Simulink environment.

Keywords: Renewable energy, Permanent-magnet synchronous generator, Variable-speed wind turbine, Grasshopper optimization algorithm, hybrid particle swarm with gravitational search algorithm, Fuzzy logic controller, Frequency converter.

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Chapter 3

NEW OPTIMIZATION METHODSBASED-PI CONTROLLER TO ENHANCE THE PERFORMANCE OF THE VSWT-PMSG