

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

ELECTRICAL POWER AND MACHINES DEPARTMENT

**MICROCOMPUTER BASED ARTIFICIAL INTELLIGENT CONTROL STRATEGIES
FOR WIND AND PHOTOVOLTAIC SOLAR ENERGY CONVERSION
AND UTILITY INTERFACE SCHEMES**

621,313
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A Thesis Submitted in Fulfilment for the Requirement
of the Degree of Doctor of Philosophy
in

Electrical Power and Machines
To Ain Shams University, Faculty of Engineering,
Elect. Power & Machines Dept.

BY

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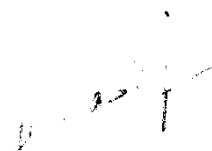
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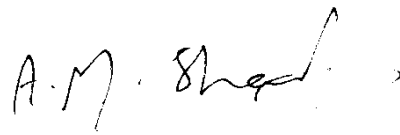
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STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Doctor of Philosophy in Electrical Engineering.

The work included in this thesis is carried out by the author in the Department of Electrical Power and Machines, Faculty of Engineering, Ain Shams University, Egypt from January, 1991 to May, 1992 and in the Department of Electrical Engineering, University of New Brunswick, Canada from June, 1992 to June 1994.

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The author acknowledges the Dept. of Electrical Power and Machines, Faculty of Engineering, Ain Shams University. Acknowledgement is dedicated to Eng. M. Yousef El-Sharkh for helping the author in the thesis writing.

I gratefully acknowledge my parents for their patience and understanding. I would like to thank my wife for her patience, hard working and encouragement during the research period.

ABSTRACT

The thesis presents novel artificial intelligent controllers for two renewable energy schemes interfaced to the utility grid. The proposed schemes are the photovoltaic-utility scheme and the wind driven induction generator-utility scheme. The proposed artificial intelligent based controllers are Fuzzy logic and artificial neural networks. The control objective is to utilize and track the reference power in the renewable energy schemes.

The main feature of the artificial intelligent controllers is to design a system with acceptable performance with presence of system uncertainties and nonlinearity. These controllers are model free design techniques, they need system heuristic data and system operator expertise.

The stochastic variations of solar insolation and wind velocity make difficulties for the renewable energy sources to commit firm supply of electricity. So some form of energy storage is required. In this thesis a renewable energy-utility interfacing technique is proposed in which the utility works as an energy storage with infinite capacity.

In wind energy schemes, a DC link is used to interface the induction generator power to the utility grid. The induction generator output is a variable voltage variable frequency. This output is rectified through a 3-phase uncontrolled bridge rectifier. Then injected to the utility grid through a smoothing reactor and a line commutated thyristor inverter. The injected power to the grid is regulated by varying the inverter firing angle. A d-q synchronously rotating frame model of the induction generator with the self excitation capacitor is utilized

in the simulation study.

In the solar energy scheme, a model of the photovoltaic solar array is utilized in the digital computer with its data acquisition card to emulate the PV array performance characteristics using a power amplifier. The output power from this PV emulator is injected to the grid through a smoothing reactor and a line commutated inverter.

Extensive digital simulations are carried out and a laboratory setup (based on microcomputer with its data acquisition card) of these schemes are implemented. The objective is to study the schemes performance with the supervision of the proposed fuzzy logic and artificial neural network controllers under wind velocity and solar insolation variations. Both simulation and experimental results confirm a robust and satisfactory performance in a wide range of operating conditions. The proposed controllers give superior performance over the conventional PI controller for the renewable energy schemes.

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