بسم الله الرحمن الرحيم

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تم رفع هذه الرسالة بواسطة / سلوي محمود عقل

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى مسئولية عن محتوى هذه الرسالة.

ملاحظات: لا يوجد

DESIGN AND IMPLEMENTATION OF FUZZY MACHINE LEARNING BASED CONTROLLER FOR MAXIMUM POWER POINT TRACKING OF A PV FARM SYSTEM

By

Mohamed Mohsen Mahmoud Helmy

A Thesis Submitted to the
Faculty of Engineering, Cairo University
in Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

in

Electrical Power and Machines Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY

GIZA, EGYPT

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Under the Supervision of

Prof. Dr. Ahmed Mohamed Ahmed Kamel

Professor of Automatic control
Electrical Power and Machines Department
Faculty of Engineering, Cairo University

Dr. Mahmoud Abd Elrahman Elnaggar

Assistant Professor of Automatic Control
Electrical Power and Machines Department
Faculty of Engineering, Cairo University

Dr. Ahmed Abd Elnasser Lasheen

Assistant Professor of Automatic Control
Electrical Power and Machines Department
Faculty of Engineering, Cairo University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY

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Approved by the Examining Committee

_____

Prof. Dr. Ahmed Mohamed Ahmed Kamel **(Thesis Main Advisor)**

Professor of System Engineering and Automatic Control

_____

Prof. Dr. Magdy Abdulghany Soliman ABOELELA **(Internal Examiner)**

Professor of System Engineering and Automatic Control

_____

Prof. Dr. Ahmed Mohamed El-Garhy **(External Examiner)**

Professor of Automatic Control Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY

GIZA, EGYPT

November 2021

Engineer's Name: Mohamed Mohsen Mahmoud Helmy

Date of Birth:	11/11/1986
Nationality:	Egyptian
E-mail:	Mohamedmohsen684@hotmail.com
Phone:	01001886441
Registration Date:	01/10/2017
Awarding Date:	/ /2021
Degree:	Master of Science
Department	ELECTRICAL POWER AND MACHINES ENGINEERING
Supervisors:	**Prof. Dr. Ahmed Mohamed Ahmed Kamel**
	Professor of Automatic control Engineering, Cairo Univetsity
	Dr. Mahmoud Abd Elrahman Elnaggar
	Assistant Professor of System Engineering and Automatic Control, Cairo Univetsity
	Dr. Ahmed Abd Elnasser Lasheen
	Assistant Professor of System Engineering and Automatic Control, Cairo Univetsity
Examiners:	**Prof. Dr. Ahmed Mohamed Ahmed Kamel** (Thesis Main Advisor)
	Professor of System Engineering and Automatic Control
	Prof. Dr. Magdy Abdulghany Soliman ABOELELA (Internal Examiner)
	Professor of System Engineering and Automatic Control
	Prof. Dr. Ahmed Mohamed El-Garhy (External Examiner)
	Professor of Automatic Control Engineering
Title of Thesis:	Design and Implementation of Fuzzy Machine Learning based Controller for Maximum Power Point Tracking of a PV Farm System
Key Words:	Machine Learning; MPPT; ANFIS; PV Farm; Fuzzy Logic

Summary:

Solar energy systems are considered one of the most important systems that researchers have been developing due to their importance in generating electrical energy, but these systems suffer from a fundamental problem, which is the dependence of the power extracted from solar panels on radiation strength and temperature, and they are by nature variable. Therefore, in this research a simulation was made to design artificial intelligence controllers such as fuzzy logic or artificial neural networks to follow the maximum power point extracted from these systems during sudden changes in temperature and solar radiation by calculating the voltage corresponding to the maximum power and then controlling the DC – DC Converter to obtain this voltage. These controllers are divided into two types, the first type is based on machine learning technology and aims to obtain the voltage value corresponding to the maximum power, while the second type aims to control the DC-DC converter to ensure the required voltage is reached. The proposed controllers were tested by modeling them with a solar cell system and DC-DC converters using the MATLAB program under different temperatures and radiation levels. The tests included actual temperatures and radiation levels registered in Cairo. The results have demonstrated the effectiveness and ability of the proposed first type controller in determining the required voltage value for the maximum power compared to traditional methods, as well as the effectiveness and ability of the second type controller built using fuzzy logic or neural networks in reaching the voltage extracted from the first type controller with high accuracy and speed compared to the second type controllers proposed.

DISCLAIMER

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Mohamed Mohsen Mahmoud Helmy **Date:**

Signature:

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Abstract

In recent years, some research has been done in the area of optimizing PV performance when combined with a wide range of loads utilizing Power Electronics converters. Such converters can be DC-DC and DC-AC single and three stage converters. Control technique for these converters is based on a number of algorithms that have been developed and optimized for Maximum Power Point (MPP) detection, such as Incremental Conductivity, Perturbation and Observation (P&O). Even though its complexity, the most common MPPT algorithm is Incremental Conductance due to several advantages compared to others.

Current research in the field of Maximum Power Point Tracking focuses on new and more flexible ways to change the size of the duty ratio step. This thesis aims to design duty ratio step size controllers to track the maximum power of a farm system to provide 400KW.

This is done using two stages of work. The first stage is to extract the voltages that give the maximum power for different temperature and irradiance using the PV cells under consideration. These data are, then, used to train a fuzzy controller using fuzzy machine learning to determine the reference voltage that gives the maximum power for certain temperature and irradiance. The second stage is to adjust the real value of the output voltage of the PV system as the previously mentioned reference voltage using conventional PI Controller tuned by both particle swarm optimization (PSO) and Ziegler-Nichols method.

Adaptive Neuro Fuzzy Inference System (ANFIS) like PI Controller and Fuzzy controller tuned using Fuzzy machine learning are, also, developed. The developed controllers are tested using temperature real data gathered during one day in Cairo. In addition, different simulation scenarios are implemented to validate the efficiency of the proposed controllers. The simulation results show that the proposed controllers monitor the PV system's MPP in short time with minimal error and low oscillation under large changes in environmental conditions. Furthermore, the results showed that ANFIS is the most powerful among the proposed controllers as a PI operator.

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