DESIGN OF MAXIMUM POWER POINT TRACKING TECHNIQUES FOR A STAND-ALONE PV SYSTEM

By

Omnia Shawky Sayed Hussian

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

In

Electronics and Communications Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Under the Supervision of

Prof. Dr. M. A. Moustafa Hassan
……………………………….
Professor of Control of Power Systems
Electrical Power Dept.
Faculty of Engineering, Cairo University

Dr. Hany M. Elsayed
……………………………….
Assistant Professor
Electronics and Communications Dept.
Faculty of Engineering, Cairo University

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Approved by the Examining Committee

____
Prof. Dr. M. A. Moustafa Hassan, Thesis Main Advisor

____
Prof. Dr. Ahmed Ali Abu-Elsaud, Internal Examiner

____
Prof. Dr. Said Abd-Almonem Wahsh, External Examiner
(Electronics Research Institute)

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2019

Engineer's Name: Omnia Shawky Sayed Hussian
Date of Birth: 1/ 9/ 1990
Nationality: Egyptian
E-mail: omnia.s.shawky@gmail.com
Phone: 01150867770
Address: El Haram St., Giza
Registration Date: 1 /10/ 2015
Awarding Date: …./…./2019
Degree: Master of Science
Department: Electronics and Communications Engineering
Supervisors:
Prof. M. A. Moustafa Hassan
Dr. Hany M. Elsayed

Examiners:
Prof. M. A. Moustafa Hassan
Prof. Ahmed Ali Abu-Elsaud
Prof. Said Abd-Almonem Wahsh
(Electronics Research Institute)

Title of Thesis:
Design of Maximum Power Point Tracking Techniques for a Stand-Alone PV System

Key Words:
PV System, Maximum Power Point Tracking, Fuzzy Logic Control, Optimization Techniques, Cuckoo Search Algorithm.

Summary:
This thesis presents the design and comparative study of maximum power point tracking techniques for stand-alone PV system. The comparison considers the performance of each technique in terms of settling time, maximum overshoot, tracking speed and tracking accuracy. The used battery requires as input a constant DC voltage input. For the purpose, the PI controller is used to obtain a constant DC voltage from boost converter in spite of changes in weather conditions. The parameters of PI controller are tuned by evolutionary techniques including different versions of particle swarm optimization and cuckoo search algorithm. Based on Simulink/Matlab simulations, it is found that best results, including total harmonic distortion, are obtained using fuzzy logic for maximum power point tracking, combined with PI battery charging controller tuned with modified adaptive acceleration coefficient particle swarm optimization.
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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: Date:

Signature:

Acknowledgments

I would like to thank ALLAH for his constant tenderness and lasting blessings. I want to thank my supervisors **Prof. Mohamed A. Moustafa Hassan** and **Dr. Hany M. Elsayed** for their help, and great efforts to complete this work.

I want to thank **my parents and brothers** for their continues support to complete my thesis and their endless love.

I would like to thank **Prof. Hassan Kamel** from Faculty of Engineering- Cairo University for his encouragement, advice, and support to complete this thesis.

I would like to thank **Dr. Mohamed Essa** from Institute of Aviation Engineering and Technology for his help to complete my thesis, and his great efforts to revise my thesis.

I want to thank my brother's wife **Omnia Mohamed** for her great efforts to revise my thesis.

I would like to thank my colleagues **Dr. Mohamed Khalifa, Eng. Ihab S. Mohamed, Eng. Ahmed AsSakka**, **Eng. Mohamed Ramadan, Eng. Khaled Abd-Elstar, Eng. Asama Abu Elaz and Hager Mohamed** for their help.

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List of Abbreviations

AACPSO	Adaptive Accelerated Coefficient Particle Swarm Optimization.
AWPSO	Adaptive Weighted Particle Swarm Optimization.
BESS	Battery Energy Storage System.
CdTe	Cadmium Telluride.
CIGS	Copper Indium/ Gallium Selenide.
CIS	Copper Indium Selenide.
CS	Case Study.
CSA	Cuckoo Search Algorithm.
FLC	Fuzzy Logic Control.
FO	Fractional Order.
FOPI	Fractional Order Proportional Integral.
FOPID	Fractional Order Proportional Integral and Derivative.
IAE	Integral Absolute Error
IBGT	Isolated Bipolar Gate Transistor
INC	Incremental Conductance.
ISE	Integral Square Error.
ITAE	Integral Time Absolute Error
ITSE	Integral Time Square Error
MAACPSO	Modified Adaptive Accelerated Coefficient PSO.
MDIC	Modified Direct Incremental Conductance.
MOS	Maximum OverShoot.
MPPT	Maximum Power Point Tracking.
OCV	Open Circuit Voltage
P&O	Perturb and Observe.
PI	Proportional Integral.
PID	Proportional Integral and Derivative.
PSO	Particle Swarm Optimization.
PV	PhotoVoltaic.
PWM	Pulse Width Modulation.
SCI	Short Circuit Current.
SPVS	Stand-alone PV system.
STC	Standard Condition.
THD	Total Harmonics Distortion.

List of Symbols

A	The Ideality Factor = 1.6
A_0	Initial Positive Constant Chosen 0.5, 1
B	The Ideality Factor = 1.6
C_1,C_2	Cognitive Coefficient and Social Coefficient
CE(K)	Change of Error
C_{min}	Minimum Capacitance
C_{oi}	Initial Acceleration Coefficient
d	Duty Cycle
D	The Crisp Output Value
D_J	The Canter of Max Or Min at The Output Mfs.
E(K)	Error Signal at Instant Sample Time k
e(t)	Error Between Input and Output
E_{go}	The Band Gap of Silicon = 1.1 ev
F_m^t	The Best Position Linked to all Particles at Iteration t
G	Radiation of PV Module (w/m^2)
g_i^t	Best Location found by particle
K	The Boltzmann Constant = 1.3805 x10^{-23}
K_1, K_2	Constant
K_d	Derivative Gain
K_i	Integral Gain
K_T	Temperature at I_{SC} = 0.0017 A/c^o
K_p	Proportional Gain
I_o	Saturation Current
F_m^t	The Best Position Linked to all Particles at Iteration t
I_{mpp}	Current at Maximum Power Point
I_{Ph}	Photo Current
I_{PV}	Output Current of PV
I_{rs}	Reverse Saturation Current
I_{SC}	Short Circuit Current
L	Scale Referring To Study Problem.
L_{min}	Minimum Inductance
ln	The Neperian Logarithm
N	Number of Particle Swarm
N_s	Number of Series Connected Cells
P(K)	Power Generated from PV
P_i^t	Best Location by i^{th} particle
Q	The Electron Charge = 1.6 x10^{-19} C
R	Output Resistance
r_1,r_2	Random numbers from 0 to 1
R_s	Series Resistance of PV