



Cairo University

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

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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.

.

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:

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Signature:

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Table of Contents

LIST OF TABLES.....	vi
LIST OF FIGURES.....	vii
LIST OF ABBREVIATION.....	x
LIST OF SYMBOLS.....	xi
ABSTRACT.....	xiii
CHAPTER 1: INTRODUCTION.....	1
1.1 Preface.....	1
1.2 Objectives of the Thesis.....	2
1.3 Outline of the Thesis.....	2
CHAPTER 2: SOLAR PHOTOVOLTAIC TECHNOLOGY AND RELATED WORKS.....	3
2.1 Fundamentals of Photovoltaic Cell.....	3
2.2.1 Types of Crystalline PV Module.....	3
2.2 Equivalent Circuit of A single Diode Photovoltaic Cell.....	4
2.3 Structure of PV Module	6
2.4 MATLAB/SIMULIK model of PV Module.....	7
2.5 Characteristics of PV Module.....	11
2.6 Stand-alone PV System.....	12
2.7 Related Works.....	13
2.8 Summary of the Chapter	15
CHAPTER 3: SYSTEM COMPONENTS AND CONTROLLER DESIGN.....	16
3.1 Introduction.....	16
3.2 DC-DC Boost Converter.....	16
3.2.1 Description of Boost Converter in Conduction Mode.....	17
3.2.2 Specification of Boost Converter.....	19
3.3 Description of the Battery.....	19
3.4 Battery Controller.....	20
3.5 Objective Functions.....	22
3.5.1 Integral Square Error.....	23

3.5.2 Integral Absolute Error.....	23
3.5.3 Integral Time Square Error.....	23
3.5.4 Integral Time Absolute Error.....	23
3.6 Controller Design.	23
3.7 Particle Swarm Optimization.....	24
3.7.1 Particle Swarm Optimization Algorithms.....	24
3.7.2 Adaptive Weighted Particle Swarm Optimization.....	25
3.7.2.1 Steps Operation of Adaptive Weighted Particle Swarm Optimization.....	27
3.7.3 Adaptive Acceleration Coefficient Particle Swarm Optimization.....	27
3.7.3.1 Procedure of Adaptive Acceleration Coefficient Particle Swarm Optimization based on Particle Swarm Optimization.....	27
3.7.4 Modified Adapted Accelerated Coefficient Particle Swarm Optimization.....	28
3.7.4.1 Procedure of Modified Adapted Accelerated Coefficient Particle Swarm Optimization based on Particle Swarm Optimization.....	28
3.7.5 Cuckoo Search Optimization Algorithm	29
3.7.5.1 Cuckoo Breeding Behavior.....	29
3.7.5.2 Steps of Cuckoo Search Algorithm.....	29
3.8 DC-AC Inverr.....	30
3.8.1 Pulse Width Modulation for Inverter.....	30
3.8.2 Unipolar Pulse Width Modulation.....	30
3.9 LC Filter.....	32
3.10 Summary of the Chapter.....	32

CHAPTER 4: SIMULATION RESULTS FOR MAXIMUM POWER POINT TRACKING TECHNIQUES.....33

4.1 Introduction.....	33
4.2 Perturb and Observe Technique.....	35
4.2.1 Drawbacks of P&O Algorithm.....	37
4.3 Incremental Conductance Technique.....	37
4.4 Open Circuit Voltage.....	40
4.4.1 Advantage and Disadvantage of Open Circuit Voltage.....	40
4.5 Short Circuit Current.....	41
4.6 Proportional Integral Derivative PID Controllers.....	43
4.6.1 Proportional Controller (P)	43
4.6.2 Proportional Integral (PI) Controller.....	43
4.6.3 Proportional Integral Derivative (PID) Controller.....	44
4.7 Fractional Order Proportional Integral Derivative	45
4.7.1 Fractional Order Proportional Integral (FOPI)	45
4.7.2 Fractional Order Proportional Integral Derivative (FOPID)	46

4.8 Modified Direct Incremental Conductance (MDIC)	46
4.9 Fuzzy Logic Control as MPPT Technique.....	48
4.9.1 Fuzzification Module.....	48
4.9.2 Inference Engine.....	51
4.9.3 Defuzzification Module.....	53
4.9.4 Advantage of Fuzzy Logic Control.....	53
4.10 Results and Simulations for Maximum Power Point Tracking Techniques.....	53
4.11 Summary of the Chapter	70
CHAPTER 5: SIMULATION RESULTS FOR BATTERY CHARGIN.....	71
5.1 Introduction.....	71
5.2 Procedure of the Thesis.....	71
5.3 Results and Discussions on Battery Charger Controller.....	71
5.4 Total harmonic Distortion.....	82
5.5 Summary of the Chapter	84
CHAPTER SIX: CONCLUSION AND FUTURE WORK.....	85
6.1 Conclusion.....	85
6.2 Related Future Work	86
REFERENCES.....	87
APPENDIX A.....	90
APPENDIX B.....	92

List of Tables

Page

Table (2-1): PV Characteristics Module for Data Canadian Solar CS6P-255P.....	11
Table (3-1): Specification Values of Boost Converter.....	19
Table (3-2): Specification of Nickel Metal Hybrid Battery.....	21
Table (4-1): Rules of Fuzzy Controller.....	51
Table (4-2): Rules of Fuzzy Set in MATLAB/ SIMULINK.....	52
Table (4-3): Power Changes with Different Irradiance and Temperature.....	56
Table (4-4): Response Time of MPPT Techniques.....	56
Table (4-5): Comparison between MPPT Techniques.....	57
Table (4-6): Comparison between Results of PI and PID Controllers.....	58
Table (4-7): Response Time with Different PI and PI Tuning Methods.....	58
Table (5-1): Parameters of PSO via Tuning PI controller.....	74
Table (5-2): Parameters of AWPSO via Tuning PI controller.....	74
Table (5-3): Parameters of AACPSO via Tuning PI controller.....	74
Table (5-4): Parameters of MAACPSO via Tuning PI controller.....	75
Table (5-5): Parameters of Cuckoo Search Algorithm via Tuning PI controller.....	75
Table (5-6): The Results for the Battery Charging Based on PI Controller.....	81
Table (5-7): Details of Total Harmonic Distortion.....	82

List of Figures	Page
Figure (2-1): A typical Photovoltaic Cell	3
Figure (2-2): Types of Crystalline PV Module.	4
Figure (2-3): Equivalent Circuit of a PV Cell.	4
Figure (2-4): Structure of a PV Array.	6
Figure (2-5): I-V Curve and P-V Curve of PV Module.	6
Figure (2-6): A PV Module Selected.	8
Figure (2-7): Power vs. Voltage Characteristics of PV Module.	8
Figure (2-8): Photo Generated Current.	9
Figure (2-9): Reverse Saturation Current at Standard Condition.	9
Figure (2-10): The Reverse Saturation Current.	10
Figure (2-11): The Output Current of PV Module.	10
Figure (2-12): Implementation of PV Array.	11
Figure (2-13): Output Power, Current Vs. Voltage at Different Temperature.	12
Figure (2-14): P-V Characteristics with Different Irradiance.....	12
Figure (2-15): Structure of A stand-alone PV System.	13
Figure (2-16): A Complete A Stand-alone PV System.	14
Figure (3-1): Boost Converter Circuit.	16
Figure (3-2): Equivalent Circuit of Boost Converter in t_{on}	17
Figure (3-3): Equivalent Circuit of Boost Converter in t_{off}	17
Figure (3-4): Boost Converter Waveforms under Continuous Conduction Mode.....	18
Figure (3-5): The MATLAB/ Simulink Model of Battery Controller.	21
Figure (3-6): Specification of Control Strategy.	22
Figure (3-7): Flow Chart of Control Battery.	22
Figure (3-8): Battery Charge Based on PI Controller.....	24
Figure (3-9): The Flow Chart of PSO.	26
Figure (3-10): Simulink Model for Unipolar PWM Circuit.....	31
Figure (3-11): IGBT Switching of Inverter.	31
Figure (3-12): Low Pass Filter.	32
Figure (4-1): Daily Change of Radiation.....	33
Figure (4-2): MPPT of PV System.	34
Figure (4-3): P-V with Different Irradiance.	34
Figure (4-4): P-V Characteristics of MPPT.	35
Figure (4-5): Flowchart of Perturb and Observe.	36
Figure (4-6): Block Diagram of P&O.	36
Figure (4-7): The Principle of Incremental Conductance.....	38
Figure (4-8): Block Diagram of INC.	38
Figure (4-9): Flowchart of Incremental Conductance.	39
Figure (4-10): Block Diagram of Open Circuit Voltage.	40
Figure (4-11): Flow Chart of Open Circuit Voltage.	41
Figure (4-12): Block Diagram of Short Circuit Current.	42
Figure (4-13): Flow Chart of Short Circuit Current.	42

Figure (4-14): Block Diagram of P Controller.	43
Figure (4-15): Block Diagram of PI Controller.	44
Figure (4-16): Block Diagram of PID Controller.	45
Figure (4-17): Block Diagram of FOPI.	45
Figure (4-18): Block Diagram of FOPID.	46
Figure (4-19): Flowchart of Modified Direct Incremental Conductance.	47
Figure (4-20): Structure of A Stand-Alone PV System with Fuzzy Logic Control.....	48
Figure (4-21): Design of Fuzzy Logic Controller.	49
Figure (4-22): Membership Function of Input and Output Variables.	50
Figure (4-23): The Overview of Fuzzy Controller by MATLAB/ Simulink.	51
Figure (4-24): A Complete Stand-Alone PV System by Simulink/ MATLAB.	54
Figure (4-25): Different Radiation with Constant Temperature (CS-I).	55
Figure (4-26): Different Radiation with Temperature (CS-II).....	55
Figure (4-27): Model P&O of MPPT Controller via a Simulink/ MATLAB.	59
Figure (4-28): Power Response Based on P&O Technique (CS I) and (CS II).	60
Figure (4-29): Simulink/ MATLAB Model of MPPT OCV Controller.....	60
Figure (4-30): Power Response Based on OCV Technique (CS-I) and (CS-II).	61
Figure (4-31): Simulink/ MATLAB Model of MPPT SCI Controller	61
Figure (4-32): Power Response Based on SCI Technique in (CS-I) and (CS-II).	62
Figure (4-33): Simulink/ MATLAB Model of MPPT PI Controller.....	62
Figure (4-34): Power Response Based on PI Technique in (CS-I) and (CS-II).	63
Figure (4-35): Power Response Based on PI Tuning by MAACPSO Technique in (CS-I) and (CS-II).....	63
Figure (4-36): Simulink/ MATLAB Model of MPPT PID Controller.....	64
Figure (4-37): Power Response Based on PID Technique in (CS-I) and (CS-II).	64
Figure (4-38): Power Response Based on PID Tuning by MAACPSO Technique (CS-I) and (CS-II).....	65
Figure (4-39): Simulink/ MATLAB Model of MPPT FOPI Controller.....	65
Figure (4-40): Power Response Based on FOPI Technique in (CS-I) and (CS-II).....	66
Figure (4-41): Simulink/ MATLAB Model of FOPID MPPT Controller.....	66
Figure (4-42): Power Response Based on FOPID Technique in (CS-I) and (CS-II).	67
Figure (4-43): Simulink/ MATLAB Model of INC with PI MPPT Controller.....	67
Figure (4-44): Power Response Based on INC Technique in (CS-I) and (CS-II)	68
Figure (4-45): Simulink/ MATLAB Model of MDIC MPPT Controller	68
Figure (4-46): Power Response Based on MDIC Technique in (CS-I) and (CS-II).	69
Figure (4-47): Simulink/ MATLAB Model of Fuzzy MPPT Controller.....	69
Figure (4-48): Power Response Based on Fuzzy Technique in (CS-I) and (CSII).....	70
Figure (5-1): A Complete Stand-Alone PV System by Simulink/ MATLAB.	72

Figure (5-2): Battery Controller via Simulink/ MATLAB.	73
Figure (5-3): Different Temperature with Constant Irradiance.	75
Figure (5-4): Power Response Based on Fuzzy Technique.	76
Figure (5-5): Vdc_Voltage and Error Based on PSO.	77
Figure (5-6): Voltage, Current and Power Load Based on PSO.	77
Figure (5-7): Vdc_Voltage and Error Based on AWPSO.	78
Figure (5-8): Voltage, Current and Power Load Based on AWPSO.	78
Figure (5-9): Vdc_Voltage and Error Based on AACPSO &MAACPSO.	79
Figure (5-10): Voltage, Current and Power Load Based on AACPSO & MAACPSO...	79
Figure (5-11): Vdc_Voltage and Error Based on Cuckoo Search Algorithm.	80
Figure (5-12): Voltage, Current and Power Load Based on Cuckoo Search Algorithm..	80
Figure (5-13): Vdc_Voltage by PI Controller Comparison with Optimization Techniques.....	81
Figure (5-14): Power Load by PI Controller Comparison with Optimization Techniques.....	82
Figure (5-15): Phase- Phase Voltage with Total Harmonic Distortion without Filter....	83
Figure (5-16): Phase- Phase Voltage with Total Harmonic Distortion with Filter.....	83
Figure (A-1): Buck Converter Circuit.....	91

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 = 1.3805×10^{-23}
K_1, K_2	Constant
K_d	Derivative Gain
K_i	Integral Gain
K_T	Temperature at $I_{sc} = 0.0017 A/^\circ C$
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 = $1.6 \times 10^{-19} C$
R	Output Resistance
r_1, r_2	Random numbers from 0 to 1
R_s	Series Resistance of PV