DEVELOPMENT OF INTELLIGENT MPPT CONTROLLERS FOR SOLAR PHOTOVOLTAIC SYSTEM

DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE

OF

MASTER OF TECHNOLOGY
IN
CONTROL AND
INSTRUMENTATION

Submitted by:

Astitva Kumar

(2K13/C&I/22)

Under the supervision of

Dr. M. Rizwan

DEPARTMENT OF ELECTRICAL ENGINEERING
DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Bawana Road, Delhi-110042

2015

DEPARTMENT OF ELECTRICAL ENGINEERING

DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Bawana Road, Delhi-110042

CERTIFICATE

I, **Astitva Kumar**, Roll No. 2K13/C&I/22 student of **M. Tech. (Control and Instrumentation)**, hereby declare that the dissertation titled **"Development of Intelligent MPPT Controllers for Solar Photovoltaic System"** under the supervision of Dr. M. Rizwan, Assistant Professor, Department of Electrical Engineering, Delhi Technological University in partial fulfilment of the requirement for the award of the degree of Master of Technology has not been submitted elsewhere for the award of any Degree.

Place: Delhi **ASTITVA KUMAR**

Date: 30.06.2015

Dr. M. RIZWAN
Assistant Professor
Department of Electrical Engineering
Delhi Technological University

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to Dr. M. Rizwan for his guidance and assistance in the dissertation. The technical discussions with him were always been very insightful, and I will always be indebted to him for all the knowledge he shared with me. His prompt responses and availability despite his constantly busy schedule were truly appreciated. He always helped me in all the technical and non-technical issues during the production of this dissertation. Without his consistent support, encouragement and valuable inputs, this dissertation would not have become possible.

I would like to express my deep gratitude to Prof. Madhusudan Singh, Head, Department of Electrical Engineering for providing his support during my project.

I would especially thank Ms. Priyanka Chaudhary and Mr. Tausif Ahmad for their invaluable and lively discussions during the tenure of this research work.

I would also like to thank my batch-mates and friends who encouraged and helped me in completing the dissertation. A special mention to Saurabh, Faizan, Siddhant and Ayushi for their continued support and motivation

Finally, I express my deep sincere thanks to my Parents, my brother who motivated and encouraged me for higher studies, without which it wouldn't have been possible.

ASTITVA KUMAR
(2K13/C&I/22)
M.Tech (Control and Instrumentation)

ABSTRACT

The ever growing demand and socio-economic development, the conventional energy sources have almost become obsolete for nurturing this demand. Thus, opening new avenues to search for the new and renewable energy. Solar photovoltaic (PV) technology is becoming more popular because of number of advantages. These advantages include zero green house emission, low maintenance cost, least limitations with regard to site installation. However, the conversion efficiency of PV technology is very low about 15-18%. Also, the power generated from PV system is varying with meteorological parameters like solar irradiance, temperature etc.

Photovoltaic is a renewable and environment friendly technique having these benefits does not solve the problem as the efficiency is dependent on various factors such as irradiance, cell temperature, dust, sunlight's spectral density. These factors affect the power output of the SPV system, this can be overcome to a great extent using control techniques to track the maximum power, and these techniques are known as Maximum Power Point Tracking.

This dissertation is an analytical study of various impressive Maximum Power Point Tracking (MPPT) algorithm using intelligent techniques such as Fuzzy Logic, ANFIS in MATLAB-Simulink module alongside the Incremental Conductance with voltage regulation. These improvised MPPT technique reduces the tracking time and also solves the various issues associated with traditional MPPT algorithms such as Perturb and Observe, Incremental Conductance. The study involves analysis of various control algorithms which in turn controls the switching of the DC-DC Boost Converter.

The research work proposes various fast and adequate tracking algorithms like fuzzy logic controller and Neuro-Fuzzy controller are tested against various meteorological parameters. Respective performance indicators have been listed for the proposed MPPT. These control techniques provide user with complete flexibility to choose the inputs and their relationship (rule base). The simulated results show that the fuzzy logic and neuro-fuzzy technique controls the integrated PV module output directly and rapidly. Thus showing the effectiveness and feasibility of the proposed controllers.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATION AND SYMBOLS

ANFIS	Adaptive Neuro-Fuzzy Inference System
ANN	Artificial Neural Networks
BPNN	Backpropagation Neural Network
COG	Centre of Gravity
FIS	Fuzzy Inference System
FLC	Fuzzy Logic Controller
INC	Incremental Conductance
MIQ	Machine Intelligence Quotient
MPP	Maximum Power Point
MPPT	Maximum Power Point Tracking
P & O	Perturb and Observe
PV	Photovoltaic
SPV	Solar Photovoltaic
C_{in}	Input Capacitance
L	Inductance
C_{out}	Output Capacitance
V_{mo}	Max. output ripple voltage
I_{mo}	Max. ripple current
P_m	Maximum Power
V_m	Maximum Voltage
I_m	Current at max. power
V_{oc}	Open cct Voltage
I_{sc}	Short cct current
N_s	Total no. cells in series

N_p	Total no. of cells in parallel
I	Solar cell current
I_D	Module diode saturation current
I_{SCref}	Module short circuit current at 25°C
q	electron charge
∂	Irradiation on the device surface
A	Ideality Factor
T	Module operating temperature in Kelvin
I_{SC}	photocurrent in (A)
k	Boltzmann Constant
$\frac{\partial P_{PV}}{\partial V_{PV}}$	Change in output power of module with respect to change in module voltage
$\frac{\partial I}{\partial V}$	Incremental conductance
ΔD	Change in duty cycle