

Artificial Neural Network-based Maximum Power Point Tracker for the Photovoltaic Application

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Abstract—This paper proposes a new artificial neural network-based maximum power point tracker for photovoltaic application. This tracker significantly improves efficiency of the photovoltaic system with series-connection of photovoltaic modules in non-uniform irradiance on photovoltaic array surfaces. The artificial neural network uses irradiance and temperature sensors to generate the maximum power point reference voltage and employ a classical perturb and observe searching algorithm. The structure of the artificial neural network was obtained by numerical modelling using Matlab/Simulink. The artificial neural network was trained using Bayesian regularisation back-propagation algorithms and demonstrated a good prediction of the maximum power point. Efficiency of proposed ANN-based MPP tracker has been estimated for linear shadow expanding and constant partial shading of any one PV module.

Keywords—photovoltaic system, artificial neural network, maximum power point tracker, efficiency, partial-shaded photovoltaic

1. INTRODUCTION

The renewable energy sources are considered as essential component of the future energy due to the rises in price of slowly depleting fossil sources and environmental concerns of nuclear power. Photovoltaic (PV) technology has become the fastest growing branch of renewable energy in the recent years. At the beginning of 2013 the total installed capacity of all PV plants have reached milestone 100GW [1], and continued to grow through the latest two year with additional 35GW in 2013 and planned 40GW in 2014.

The expansion of PV technology in power installations across the world restrains by relatively low overall efficiency of conversion of insolation into electricity and its dependence on day time prevent. Therefore the increasing conversion efficiency is the crucial issue of photovoltaic technology attracted attention of researches over the last few decades.

The total efficiency of PV systems can be increased in some ways. The first way is development of new materials able to improve the irradiance conversion. The second approach is the use of PV panel orientation systems (solar trackers) to adjust its position to perpendicular the photosensitive surface to sun rays. Such tracker can partially compensate the irregularity of power production during the day (especially in morning and in evening hours). They can be classified by hanger type as single-axial [2] and bi-axial [3]. The efficiency of solar trackers depends on many conditions, including tracker type, PV system location coordinates, irradiance level, etc. Lorenzo et al shown [4] that the average annual efficiency improvement of PV systems using trackers can reach 40%.

The third way to improve overall efficiency is based on maximum power point tracking (MPPT) on the P - I curve of PV panels. Such trackers can adjust a load point on the P - I curve of PV to produce a maximum power. The main principle of operation of such devices is changing resistance of the converter (DC/DC, DC/AC) to equal it with PV internal resistance [5], [6], [7], [8], [9].

Maximum power point (MPP) can be searched and determined using different control techniques. Classical methods such as perturb and observe (P&O) [10] or incremental conductance (IncC) has been extensively studied in recent years. However, these techniques provide proper operation under uniform irradiance level only. Non-uniform irradiance, such as partial shadowing of some PV modules or even some PV cells can change P - I curve (Fig. 1) and make some local MPP, whereas classical MPPT algorithms search one maximum point only. Neither P&O nor other classical algorithms can identify the type of MPP (global or local) has been founded.

However, there are some MPPT techniques which can find the global MPP for partial-shaded PV modules, for example,

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Modern Maximum Power Point Tracking Techniques for Photovoltaic Energy Systems Ali M. Eltamaly, Almoataz Y. Abdelaziz, 2019-08-01 This book introduces and analyses the latest maximum power point tracking MPPT techniques which can effectively reduce the cost of power generated from photovoltaic energy systems It also presents a detailed description analysis and comparison of various MPPT techniques applied to stand alone systems and those interfaced with electric utilities examining their performance under normal and abnormal operating conditions These techniques which and can be conventional or smart are a current hot topic and this book is a valuable reference resource for academic researchers and industry professionals who are interested in exploring and implementing advanced MPPT for photovoltaic systems It is also useful for graduate students who are looking to expand their knowledge of MPPT techniques

Next-Generation Artificial Intelligence Driven Smart and Renewable Energy Provas Kumar Roy, Sunanda Hazra, Chandan Paul, 2025-07-07 To provide for a sustainable future the potential synergies at the dynamic intersection of renewable energy RE incorporated with smart energy and artificial intelligence AI must be exploited RE is crucial to preserve the environment Energy involving various systems must be optimized and assessed to provide better performance However the design and development of RE systems remains a challenge Advanced optimization techniques AI and machine learning ML plays a crucial role in implementing the latest innovative research in the field of renewable energy integrated electrical systems This book also describes the practical challenges encountered and the solutions and future scope to be adopted Applications of a variety of advanced optimization and AI techniques in the design and development of RE integrated systems are discussed to provide new solutions in the RE domain Key features Discusses modern modeling control approaches for improving renewable energy integrating artificial intelligence driven power systems Describes the principles and methods of renewable energy generation technologies and an analysis of their implementation management and optimization and related economic advantages Presents critical information on the technological design and policy issues that must be taken into considered while implementing a smart grid Explains of the metaheuristic optimization algorithm for complex electrical systems and the whale optimization algorithm based multi objective hydrothermal scheduling Covers the electric vehicle charging station in the distribution network and transient stability constraint optimal power flow problem using chaotic quasi oppositional chemical reaction optimization The topics covered including microgrids wind power solar photo voltaic PV optimal power flow OPF grid connected inverter electric vehicle combined heat and power economic dispatch FACTS tools for smart energy harmonic impedance of a salient pole synchronous generator HI maximum power point tracking MPPT and advanced optimization techniques Next Generation Artificial Intelligence Driven Smart and Renewable Energy is ideal for academicians practitioners teachers engineers industry professionals researchers and students in diverse fields including electrical engineering electronics and communications engineering energy and environmental engineering *Optimizing Solar*

Photovoltaic Systems Abdelkhalek Chellakhi, Said El Beid, 2025-06-22 This book deals with the forefront of solar PV innovation focusing on the critical role of Maximum Power Point Tracking MPPT techniques in enhancing energy efficiency It investigates many topics including the fundamentals of solar energy DC DC converters and battery technologies Detailed analyses of prevalent MPPT algorithms underscore their pivotal impact on system performance Central to this work is the development and rigorous validation of cutting edge MPPT strategies using advanced tools such as MATLAB Simulink and Proteus environments for simulations alongside experimental setups featuring the dSPACE DS1104 controller board Readers will discover innovative MPPT approaches that promise accelerated convergence speeds minimized power losses and heightened tracking efficiency crucial advancements for the expansive deployment of standalone PV systems This book is a must read for researchers engineers and renewable energy enthusiasts seeking to advance solar PV technology and surmount current barriers It concludes with a forward looking perspective on future research avenues reaffirming solar energy as the cornerstone of sustainable power for future generations Tailored for researchers in renewable energy electrical engineering professionals and advanced students in related fields this book offers a definitive roadmap for optimizing solar photovoltaic systems through state of the art MPPT techniques

Attainment of SDGs through the Advancement in Solar PV systems Praveen Kumar Balachandran, Sudhakar Babu Thanikanti, Bamidele Victor Ayodele, Murat Fahrioglu, Nnamdi Nwulu, 2024-11-15 With less than a decade until we reach 2030 it is crucial to address the deep inequalities affecting not only our health but also our quality of life and the economy of countries worldwide Few of the UN's Sustainable Development Goals SDGs can be directly and indirectly achieved through the implementation of renewable energy systems with a significant role being played by solar photovoltaic PV systems Solar PV systems are considered one of the most efficient methods of providing clean electrical energy which is vital to attaining these goals Numerous researchers across the globe are currently focusing on improving efficiency reducing costs recycling reconfiguring and developing materials for solar PV systems By utilizing renewable energy systems for daily needs such as power generation agriculture EV charging among others we can contribute to effectively achieving the SDGs However it is essential to assess and highlight the level of attainment of SDGs in ongoing research of solar PV systems This topic aims to provide a comprehensive analysis of the goals and bridge the gap between research and the aim of research in SDGs

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China **Neural Networks for Solar Panel Maximum Power Point Tracking** Christopher Bryan,2020 Solar panels convert solar energy that Earth receives from the sun into electrical energy without producing pollutants The power that the solar panels output can vary depending on the operating conditions and the load the panel is connected to Maximum power point tracking methods are used to correct and maximize the power that the panel is generating A machine learning algorithm called a neural network is one of the many maximum power point tracking techniques available Neural networks can provide more desirable results than the conventional methods such as the perturb and observe This thesis focuses on training a neural network to accept input factors such as irradiance cell temperature voltage and current in order to output the voltage of the point where the panel produces the maximum amount of power The network is evaluated on how well it is able to find a relation between the inputs and outputs In addition the accuracy of the network s predictions is statistically evaluated The network is tested to determine which inputs have the largest effect on tracking the maximum power point Lastly the conventional and neural network method are compared by testing the average power produced in simulations on MATLAB Simulink as well as a real world test

Measurement Technology and its Application Prasad Yarlagadda,Yun Hae Kim,2012-12-13 Selected peer reviewed papers from the 2012 International Conference on Measurement Instrumentation and Automation ICMIA 2012 September 15 16 2012 Guangzhou China Applied Energy Technology Ai Jie Wang,Kin Che Lam,Ren Jie Dong,George Zhao,2013-08-16 Selected peer reviewed papers from the 2013 2nd International Conference on Energy and Environmental Protection ICEEP 2013 April 19 21 2013 Guilin China **The Engineering Index Annual** ,1992 Since its creation in 1884 Engineering Index has covered virtually every major engineering innovation from around the world It serves as the historical record of virtually every major engineering innovation of the 20th century Recent content is a vital resource for current awareness new production information technological forecasting and competitive intelligence The world s most comprehensive interdisciplinary engineering database Engineering Index contains over 10 7 million records Each year over 500 000 new abstracts are added from over 5 000 scholarly journals trade magazines and conference proceedings Coverage spans over 175 engineering disciplines from over 80 countries Updated weekly

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