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

Oleksandr Veligorskyi

Industrial Electronics Department, Chernihiv National University of Technology,
95 Shevchenko Street, Chernihiv, 14027, Ukraine
oleksandr.veligorsky@inel.stu.cn.ua

Roustiam Chakirov

Department of Electrical and Mechanical Engineering, Bonn-Rhein-Sieg University of Applied Science,
20 Grantham–Allee, Sankt Augustin, D-53757, Germany
roustiam.chakirov@h-brs.de

Yuriy Vagapov

Department of Engineering and Applied Physics, Glyndwr University, Plas Coch, Mold Road, Wrexham, LL11 2AW, UK
y.vagapov@glyndwr.ac.uk

Abstract—This paper proposes a new artificial 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 backpropagation 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

I. 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 restraints 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 at all 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 *V-J* curve of PV panels. Such trackers can adjust a load point on the *V-J* 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 (InC) 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-V* 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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