energies

MDPI

Article

Active Charge Balancing Strategy Using the State of Charge Estimation Technique for a PV-Battery Hybrid System

Md Ohirul Qays [1], Yonis Buswig [1], Md Liton Hossain [2,*] and Ahmed Abu-Siada [2]

[1] Department of Electrical and Electronic Engineering, Faculty of Engineering, Universiti Malaysia Sarawak, Kota Samarahan 94300, Sarawak, Malaysia; 18020101@siswa.unimas.my (M.O.Q.); byonis@unimas.my (Y.B.)
[2] School of Electrical Engineering, Computing and Mathematical Sciences, Curtin University, Perth 6102, Australia; a.abu-siada@curtin.edu.au
* Correspondence: mdliton.hossain@postgrad.curtin.edu.au

Received: 30 May 2020; Accepted: 1 July 2020; Published: 3 July 2020

Abstract: Charging a group of series-connected batteries of a PV-battery hybrid system exhibits an imbalance issue. Such imbalance has severe consequences on the battery activation function and the maintenance cost of the entire system. Therefore, this paper proposes an active battery balancing technique for a PV-battery integrated system to improve its performance and lifespan. Battery state of charge (SOC) estimation based on the backpropagation neural network (BPNN) technique is utilized to check the charge condition of the storage system. The developed battery management system (BMS) receives the SOC estimation of the individual batteries and issues control signal to the DC/DC Buck-boost converter to balance the charge status of the connected group of batteries. Simulation and experimental results using MATLAB-ATMega2560 interfacing system reveal the effectiveness of the proposed approach.

Keywords: active battery balancing; backpropagation neural network; DC/DC Buck-boost converter; PV-battery integrated system; state of charge estimation

1. Introduction

In the last few decades, photovoltaics (PV) have been broadly used as a cost effective and reliable renewable energy source with the aim of reducing the reliance on fossil fuel used in conventional thermal generation [1]. In [2], a detailed PV model is investigated using an artificial neural network (ANN). However, adopting such model in practical PV systems increases the implementation time and complexity when compared to classical models. A maximum power point tracking (MPPT) system is essential for PV systems to yield the maximum accessible power irrespective the irregular solar irradiance and atmospheric condition. A combination of Adaptive neuro-fuzzy inference system (ANFIS) and hill climbing (HC) MPPT technique is presented in [3]. Reported results outperformed the tracking precision of the conventional MPPT technique. To increase the profit of the PV system during partial shading events, an adaptive perturb and observation (P&O) MPPT algorithm is proposed [4]. However the proposed algorithm is only valid for monocrystalline and polycrystalline-based PV panels. Ramp and step alterations of solar radioactivity was used to test the developed P&O MPPT technique. Results show that the proposed technique is of quicker tracking speed than the conventional method.

During cloudy days and night-time, battery energy storage systems (BESS) play an important role for providing off-grid power [5–7]. In [8], a 1.5 kW PV-battery integrated system is simulated using HOMER software to assess the battery lifetime. Simulation was conducted by keeping the battery depth of discharge (DOD) within 50~80%. The research reveals that the greenhouse gas (GHG) effect of the