applied sciences

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An Intelligent Controlling Method for Battery Lifetime Increment Using State of Charge Estimation in PV-Battery Hybrid System

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Received: 16 October 2020; Accepted: 5 December 2020; Published: 9 December 2020

Abstract: In a photovoltaic (PV)-battery integrated system, the battery undergoes frequent charging and discharging cycles that reduces its operational life and affects its performance considerably. As such, an intelligent power control approach for a PV-battery standalone system is proposed in this paper to improve the reliability of the battery along its operational life. The proposed control strategy works in two regulatory modes: maximum power point tracking (MPPT) mode and battery management system (BMS) mode. The novel controller tracks and harvests the maximum available power from the solar cells under different atmospheric conditions via MPPT scheme. On the other hand, the state of charge (SOC) estimation technique is developed using backpropagation neural network (BPNN) algorithm under BMS mode to manage the operation of the battery storage during charging, discharging, and islanding approaches to prolong the battery lifetime. A case study is demonstrated to confirm the effectiveness of the proposed scheme which shows only 0.082% error for real-world applications. The study discloses that the projected BMS control strategy satisfies the battery-lifetime objective for off-grid PV-battery hybrid systems by avoiding the over-charging and deep-discharging disturbances significantly.

Keywords: backpropagation neural network (BPNN); battery management system (BMS); dSPACE 1104; energy storage; PV-battery integration; state of charge (SOC)

1. Introduction

Photovoltaics (PVs) have been widely used as a reliable and cost effective renewable energy source in order to reduce the dependency on fossil fuels conventional generation [1]. The performance of PV systems can be investigated through detailed modeling and simulation analysis [2]. In this regard, artificial neural network (ANN) model for PV system has been recently used instead of the classical one diode and five parameters (1D + 5P) model. While the ANN model revealed a better performance, the execution time is long with large data required for training and testing the ANN model. The PV cells are classified into two main categories, namely, double diode and single diode modules [3,4]. While high accuracy PV panel is characterized by double diode module, the structural complexity depicts low analytical speed. Thus, the equitable trades between accuracy and easiness give advantage for single