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ORIGINAL CONTRIBUTION

Artificial Neural Network Grid-Connected MPPT-Based Techniques for Hybrid PV-WIND with Battery Energy Storage System

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Abstract A hybrid photovoltaic–wind–battery–microgrid system is designed and implemented based on an artificial neural network with maximum power point tracking. The proposed method uses the Levenberg–Marquardt approach to train data for the ANN to extract the maximum power under different environmental and load conditions. The control strategies adjust the duty cycle of a DC boost converter to achieve maximum power output for photovoltaic and wind energy systems. DC bus voltage implements voltage control using a bidirectional converter with a battery, and the current flow is controlled by an inverter control for the grid-side converter based on the state of charge of the battery and the photovoltaic current received. A phase-locked loop for frequency and phase synchronization of the grid and an LCL filter to eliminate harmonics in the single-phase grid are also integrated into the microgrid system.

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Introduction

The solar and wind are clean, renewable sources of energy. Due to the nonlinear characteristics of solar radiation, photovoltaic systems cannot provide optimal output. Wind speed is unpredictable and fluctuating, making it challenging to extract consistent energy from the wind. Artificial intelligence techniques for energy harvesting can improve performance, quality and speed compared to conventional methods. A microgrid based on solar and wind power has been proposed by Saude for the moon and Mars [1]. PV-wind-battery-wind system with a multifunctional control technique for the grid-side converter is presented [2]. The power flow by in microgrid bidirectional converter considering SOC condition of battery is discussed [3]. The firefly algorithm-based LCL filtered grid-connected microgrid system is implemented [4]. PV–wind–battery–microgrid system was implemented [5]. Multilevel converter with a common DC bus having DDPMSG, a photovoltaic array and BECS is proposed [6]. An optimal system with wind, solar and grid is implemented [7]. UPQC FLC EVA technique is used in renewable energy systems for power enhancement and grid stabilization [8], and inverter techniques for grid-connected photovoltaic systems are discussed [9]. Photovoltaic system with a bidirectional LLC converter controlled and optimized [10]. The design and modeling of an energy management system were presented [11]. PSO-trained feedforward neural network for PV array was presented [12]. LM, BR, and SCG algorithms on PV with ANN were employed [13].Wind with ANN contributed insights into LM superiority without considering battery aspects and integration [14]. Investigations

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