Chapter 11
Using AI Techniques to Improve the Power Quality of Standalone Hybrid Renewable Energy Systems

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ABSTRACT

As a developed and environmentally benign alternative for energy generation, renewable energy sources (RES) have attracted a lot of attention. The issue of energy quality, however, is one of the most difficult integration problems for RES. Voltage and frequency violations caused by waveform instability in the energy production from RES can harm equipment and lower the reliability of the power supply. In recent years, renewable energy sources like wind and solar power have drawn a lot of attention as environmentally friendly substitutes for traditional energy sources. Systems with artificial intelligence (AI) are becoming more and more common for use in automation, automated automation, and data analysis. In this research, the authors present a unique theory for an AI system that combines solar and wind energy to power AI applications. In order to improve the effectiveness and efficiency of AI systems, the suggested system makes use of the complementary properties of solar and wind energy, optimizing their generation and utilization.

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INTRODUCTION

Renewable energy sources like PV, wind, hydro, etc., are now becoming increasingly popular due to the acute depletion of fossil fuels and pollution of the atmosphere. Solar and wind energy resources are abundantly available worldwide. Due to the fluctuating nature of renewable energy resources, power generation from renewable energy systems is intermittent. The combination of two or more energy sources with the storage system was inspired by these conditions (Arul et al., 2015). A remote hybrid system gives greater efficiency with low energy production costs, compared to a single source. It is essential to care for changes in the generated power which vary from time to time. In the literature, various types of HRES are introduced which work in grid-connected or stand- alone modes. HRES system energy management is completed using a PI controller (Ahmed et al., 2018). It is done by controlling a buck-boost bi-directional converter for battery charging and discharging. A current control strategy for power balance is introduced in the PI controller. The conventional controller strategy depends on mathematical system modeling. Hybrid systems are one effective solution for electrical energy generation, specifically for remote sites or for a micro-generation unit linked to a weak AC grid (Alexander & Thathan, 2015). Hybrid systems combine several conventional or renewable energy sources interconnected through a DC bus. For an isolated area, the association of electro- chemical storage with the hybrid system eliminates the diesel generator (Arezki & Boudour, 2014). In this condition, we describe an integrated generation system acquired via combining PV and wind turbines with storage batteries. This system is to overcome periods of inadequate generation and for system control. In hybrid systems, different topologies are available, depending on the interface converters between sources and the method of interconnection. According to this topology, the interconnection of the sources ensures maximum energy transfer, and the investigation of energy losses involves power conditioning converters as well as optimal control and energy management (Chauhan & Saini, 2014). The present work aims to develop the idea of hybrid system configuration, dynamic modeling, energy management and control strategies. For different operating conditions, the author proposes and investigates an efficient control strategy for a standalone hybrid solar-wind system. Due to the uninterrupted demand for energy, batteries are used as a backup in the hybrid system. So, the suggested system is efficient for working under variable weather and load conditions (Chishti et al., 2019).

REVIEW OF LITERATURE

The literature review provides an overview of power quality issues in HRES and the application of AI techniques for mitigating these issues. Various AI techniques such