Solar intelligent power generation system

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Graph showing power and voltage relationship14.

This work aims to make a substantial contribution to the field of solar energy systems and control algorithms.

Specifically, it evaluates a highly advanced PV model for MPPT tacking.

Our focus extends to the rigorous evaluation of ten distinct MPPT controllers, including conventional methods such as INC, P& O, INC-PSO, P& O-PSO and advanced approaches employing AI such as ANN, FLC, ANFIS, PSO, ANN-PSO and FLC-PSO.

The crux of our contribution lies in the comprehensive comparative analysis of these controllers, assessing key performance parameters such as maximum output voltage, extracted maximum power, time response dynamics, design complexity, and system stability.

The ultimate goal of this research is to guide the scientific community in selecting and optimizing MPPT algorithms for improved solar energy harvesting.

A state-of-the-art literature review is conducted to analyze the research gap and present the novelty of the proposed technique. The Study presents a novel MPPT method utilizing Artificial Neural Networks (ANN) to efficiently track the maximum power generated by a PV panel. The proposed ANN-based MPPT algorithm demonstrates rapid and accurate adaptation to changing meteorological conditions, including variations in temperature and solar radiation. Comprehensive research includes the design and modeling of a PV system structure in conjunction with the ANN-MPPT controller. The main goal of the study is to develop a high-performance ANN-based MPPT controller for solar applications.

In15, the authors introduced the Fuzzy Logic (FL) MPPT algorithm, a novel fuzzy logic-based method for monitoring the maximum power point of PV arrays. Unlike standard FL-MPPT methods that employ the change in slope of P-V characteristics, the proposed technique uses a new parameter termed "Ea" that is generated from I-V characteristics. This additional parameter improves tracking performance in a variety of environmental conditions (ECs) and increases the precision with which duty ratio changes may be computed. Using the "Ea" parameter, the approach successfully distinguishes between the operating point"s placement in the Voltage Source Region (VSR) or Current Source Region (CSR) and its proximity to the MPP region.

Another study highlights the importance of MPPT controllers for optimizing the performance of solar (PV) modules16. The authors present a comparison of Adaptive Neuro-Fuzzy Inference System (ANFIS)-based MPPT controller architecture, an FL power controller, a PV module, an ANFIS reference model, and a DC-DC boost converter. Through simulations in the MATLAB/Simulink environment, the proposed ANFIS-based MPPT controller successfully harvests the maximum power from the PV module under a variety of weather circumstances, contributing significantly to the advancement of MPPT methods for solar energy systems.

Another study by21 aims to enhance the performance of microgrid systems by creating a self-adapting energy management model that integrates optimal ANN. The proposed model is composed of a series of artificial neural networks that have been optimized individually through the application of PSO. The model aims to estimate and provide essential data to the energy management system to enhance the microgrid"s integration of various energy sources. After being constructed in MATLAB/Simulink, the model is validated using experimental data.

A novel hybrid Fuzzy Particle Swarm Optimization (FPSO) technique, in conjunction with a photovoltaic-fed shunt active power filter, is proposed by22 to increase power quality and produce clean electricity. MPPT is a function of the FPSO system, which tracks the MPP and extracts as much energy as possible from the PV system. Fuzzy logic and synchronous reference frame theory govern the photovoltaic-fed shunt active power filter, which connects the boost converter output to the grid. The results demonstrate that the recommended controller performs well in a variety of load circumstances, resulting in improved power quality and more environmentally friendly electricity distribution.