ANALYSIS AND DESIGN OF ARTIFICIAL NEURAL NETWORK BASED DROOP CONTROL FOR AUTONOMOUS HYBRID MICROGRID

Abstract
The increasing integration of renewable energy sources such as solar and wind into microgrids presents challenges in maintaining voltage and frequency stability, particularly in islanded mode. This study proposes an Artificial Neural Network (ANN)-based droop control strategy to enhance the performance of autonomous hybrid microgrids comprising photovoltaic (PV) and wind energy conversion systems (WECS). Unlike traditional droop control, which is sensitive to load variations and requires precise coefficient settings, the ANN-based approach dynamically adjusts control parameters to stabilize system frequency and voltage, minimizing total harmonic distortion (THD) during load fluctuations. The ANN was trained using data derived from a single distributed generation (DG) system, utilizing a feedforward neural network (FFNN) and the scaled conjugate gradient algorithm.

The hybrid microgrid is modeled in MATLAB/SIMULINK, incorporating MPPT techniques using Grey Wolf Optimization (GWO) for PV systems and optimal power control for WECS. Simulation results demonstrate that the proposed control strategy achieves significant improvements in stability and power quality, with reduced THD compared to conventional methods. This innovative approach provides a robust and adaptive solution for modern microgrid management, addressing the variability of renewable energy sources.

Keywords: Artificial Neural Network (ANN), Droop Control, Grey Wolf Optimization (GWO), Microgrid, Total Harmonic Distortion (THD), Voltage Source Converter (VSC), MATLAB/SIMULINK.