IEEE Access

Volume 9, Issue 11, 2021, Pages 933-954

Fractional-Fuzzy PID Control Approach ofPhotovoltaic-Wire Feeder System (PV-WFS):Simulation and HIL-Based ExperimentalInvestigation

Badreddine BABES, Fahad Albalawi, Noureddine Hamouda, Sami KAHLA, Sherif S. M. Ghoneim

Abstract: The utilization of solar photovoltaic (PV) generator as a power source for wire feedersystems (WFSs) of arc welding machines is one of the promising domains in solar PV applications. Thisarticle proposes a new type of welding WFS and investigates the PV penetrated energy systems. Theproposed system comprises of a solar PV generator, a DC/DC buck converter, and a permanent magnet DC(PMDC) motor. The power of the proposed standalone solar photovoltaic-wire feeder system (PV-WFS)can be widely improved using an intelligent fractional-order fuzzy proportional integral derivative (FOFuzzy-PID) regulator based on perturbing and observe (P&O) MPPT method. In this article, a FO-FuzzyPID regulator is also designed for a PMDC motor driven welding WFS system. Which will then control thewire feed rate of the welding WFS system. Furthermore, the dynamic reaction of the proposed solar PVWFS depends on the coefficients of these FO-Fuzzy-PID regulators, which are adjusted by a meta-heuristictuning algorithm based on particle swarm optimization (PSO) technique. The proposed strategy is testedusing MATLAB simulations and experimentally verified in real-time on a Hardware-in-the-loop (HIL)testing platform using a dSPACE®1104 board-based laboratory setup. Simulation and experimental resultsare acceptable and demonstrate the effectiveness, precision, stability, and dynamic reaction of the suggestedoptimized wire feeder regulating system and the considered intelligent P&O MPPT technique.

Keywords : Buck converter, fractional-order fuzzy PID regulator, MPPT technique, PSO algorithm, PV module, wire feeder system (WFS).