

Fractional-Fuzzy PID Control Approach of Photovoltaic-Wire Feeder System (PV-WFS): Simulation and HIL-Based Experimental Investigation

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Abstract: The utilization of solar photovoltaic (PV) generator as a power source for wire feeder systems (WFSs) of arc welding machines is one of the promising domains in solar PV applications. This article proposes a new type of welding WFS and investigates the PV penetrated energy systems. The proposed 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 the wire 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-heuristic tuning algorithm based on particle swarm optimization (PSO) technique. The proposed strategy is tested using 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 results are acceptable and demonstrate the effectiveness, precision, stability, and dynamic reaction of the suggested optimized 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).