

Particle Swarm Optimization of Fuzzy Fractional $PD_{\mu}+I$ Controller of a PMDC Motor for Reliable Operation of Wire-Feeder Units of GMAW Welding Machine

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Abstract: In this article, we consider the development of an optimal control approach based on fuzzy fractional $PD_{\mu}+I$ controller to improve the speed error-tracking and control capability of a permanent magnet DC Motor (PMDC) driven wire-feeder systems (WFSs) of gas metal arc welding (GMAW) process. The proposed controller employs an optimized fractional-order proportional derivative + integral ($PD_{\mu}+I$) controller that serves to eliminate oscillations, overshoots, undershoots and steady state fluctuations of the PMDC motor and makes the wire-feeder unit (WFU) has fast and stable starting process as well as excellent dynamic characteristics. The fixed controller parameters are meta-heuristically selected via a particle swarm optimization (PSO) algorithm. Numerical simulations are performed in MATLAB/SIMULINK environment and the performance of the proposed fuzzy fractional $PD_{\mu}+I$ controller is validated. The simulation tests clearly demonstrate the significant improvement rendered by the proposed fuzzy $PD_{\mu}+I$ controller in the wire-feeder system's reference tracking performance, torque disturbance rejection capability and robustness against model uncertainties.

Keywords : GMAW process, Wire-feeder System (WFS), fuzzy fractional $PD_{\mu}+I$ controller, Particle Swarm Optimization (PSO) algorithm