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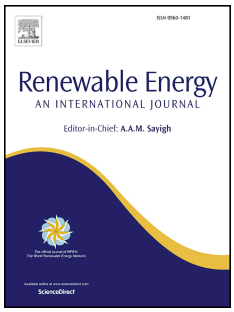

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Passivity-based Sliding-mode Control Design for Optimal Power Extraction of a PMSG based Variable Speed Wind Turbine

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Abstract

This paper proposes a novel passivity-based sliding-mode control (PB-SMC) scheme of permanent magnetic synchronous generator (PMSG) for maximum power point tracking (MPPT). A storage function is constructed based on the passivity theory at first, in which the beneficial system nonlinearities, e.g., which can make the derivative of storage function to be more negative, are carefully remained so as to improve the system damping while all the other system nonlinearities are fully removed. Then, an additional input is used to lead the closed-loop system to be output strictly passive via energy reshaping, meanwhile a sliding-mode control (SMC) is incorporated to greatly enhance the system robustness against various uncertainties of PMSG. Hence, PB-SMC can simultaneously own the promising merits of improved system damping and significant robustness, together with a globally consistent control performance under various operation conditions. Case studies including step change of wind speed, stochastic wind speed variation, pitch angle variation, and generator parameter uncertainties, are undertaken which verify the effectiveness and superiority of PB-SMC compared to that of other typical controllers. Lastly, a dSpace based hardware-in-loop (HIL) test is carried out to validate the implementation feasibility of PB-SMC.

Keyword PMSG, MPPT, passivity-based sliding-mode control, energy reshaping, storage function

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