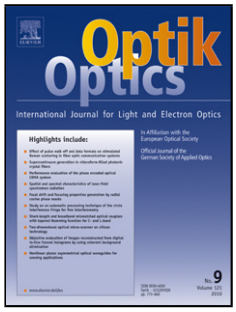

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Composite Backstepping Control with Finite-Time Convergence

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Abstract

A new robust backstepping controller with finite-time convergence for a class of uncertain nonlinear systems has been presented in this paper. The proposed controller is essentially a composite method, which consists of classical backstepping technique, extended state observer (ESO) and finite-time convergent differentiator (FTCD). More specifically, the ESO is used to estimate and compensate the mismatched as well as the matched uncertainties while the FTCD is adopted to compute the time derivatives of the virtual control laws and the reference signal. By effectively real-time estimation of ESO, the presented algorithm requires no information on the lumped uncertainties and the so-called high-gain controller is avoided completely. With the aid of Lyapunov theory, the finite-time stability of the closed-loop system is established in theory. An illustrative example of missile angle-of-attack autopilot design is given and some simulations are carried out to demonstrate the superiority of the proposed method.

Keywords: Backstepping; Extended state observer; Finite-time convergent differentiator; Mismatched uncertainty; Missile autopilot; Angle-of-attack tracking