

# A Practical, Nonlinear Disturbance Observer for Integrator Cascades under a Structural Condition

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**Abstract:** A disturbance observer is proposed for a class of systems comprising a set of coupled integrator cascades. Based on analysis of a quadratic Lyapunov function constructed by the linear components of the estimate error dynamics, provided the vector fields are bounded and Lipschitz continuous, if the system satisfies 1. a structural condition and 2. a negative condition, the disturbance estimate error is guaranteed to converge exponentially to a neighborhood of the origin. The size of such a positively invariant set can be made arbitrarily small as long as the system is practically observable. The simulation result using field testing data of an autonomous underwater vehicle indicates the effectiveness of the proposed observer and its potential to be adopted in real-world applications. This paper mainly contributes to: 1. demonstrating a way to leverage the system properties in constructing a sufficient condition for observer design, and 2. introducing the concept of practical observability.

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