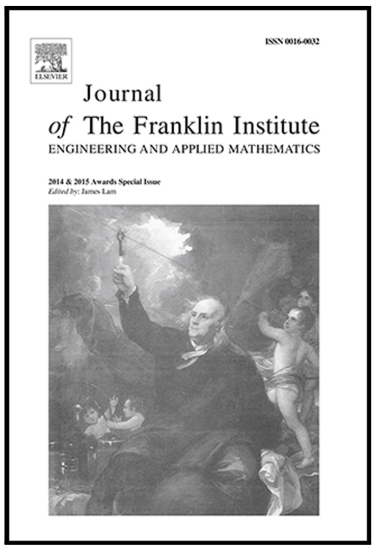

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Output feedback stabilization of high-order nonlinear systems with polynomial nonlinearity

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Abstract

In this paper, the problem of output feedback stabilization for high-order nonlinear systems with more general low-order and high-order nonlinearities multiplied by a polynomial-type output-dependent growth rate is studied. By constructing the novel Lyapunov function and observer, based on the homogeneous domination and adding a power integrator methods, an output feedback controller is developed to guarantee that the equilibrium of the closed-loop system is globally uniformly asymptotically stable.

Keywords: High-order nonlinear systems, polynomial nonlinearity, output feedback stabilization, asymptotical stability.

1. Introduction

In this paper, we study high-order nonlinear systems

$$\begin{aligned}&\dot{\eta}_i(t) = \eta_{i+1}^{p_i}(t) + \phi_i(t,\eta(t)), \quad i = 1,\cdots,n-1,\\ &\dot{\eta}_n(t) = u^{p_n}(t) + \phi_n(t,\eta(t)),\\ &y(t) = \eta_1(t),\end{aligned} \tag{1}$$

where $\eta(t) = (\eta_1(t),\cdots,\eta_n(t))^\top \in R^n$, $u(t) \in R$ and $y(t) \in R$ are system state, control input and output, $\eta_2,\cdots,\eta_n$ are unmeasurable. For $i = 1,\cdots,n$, $\phi_i : R^+ \times R^n \to R$ is an unknown continuous nonlinear function with $\phi_i(t,0) = 0$, $p_i \in R_{odd}^{\geq 1} \triangleq \{\frac{p}{q} \in R^+ \text{: } p \text{ and } q \text{ are odd integers}, p \geq q\}$. System (1) is called as high-order system if there is at least one $p_i > 1$ for $i = 1,\cdots,n$.

The problem of global output feedback control for nonlinear systems (1) has been paid attention by many authors. For the case of $p_i = 1$, when nonlinearities satisfy linear growth condition on the unmeasured states, [1] constructed a linear output feedback controller by feedback domination method. [2] studied global asymptotic stabilization by output feedback for systems whose nonlinear terms admit an incremental rate only depending on the measured output. [3], where the nonlinearities are allowed to be linear on the unmeasured states with polynomial-type output-dependent growth rate, proposed a linear output feedback with dynamic high gain. By introducing a rescaling transformation with a dynamic factor, [4] achieved output feedback stabilization of system (1) satisfying

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