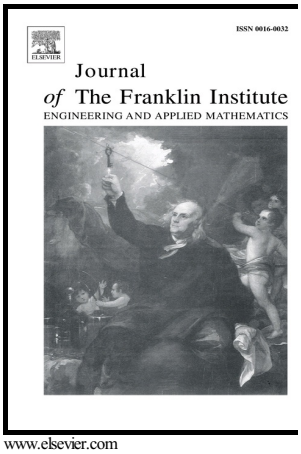

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Global Output Feedback Practical Tracking for Time-Delay Systems with Uncertain Polynomial Growth Rate

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Abstract

In this paper, the problem of global practical output tracking is investigated by output feedback for a class of uncertain nonlinear time-delay systems. Compared with the existing results, we allow the nonlinearities to nonlinearly grow in unmeasured free-delay and time-delay states with the uncertain time-delay output polynomial growth rate. Based on the ideas of universal adaptive control and dead zone, we develop an adaptive high-gain observer with a novel monotone non-decreasing dynamic law. By the Lyapunov-Krasovskii theorem, a memoryless controller is constructed to achieve global practical output tracking for uncertain nonlinear systems with multiple time delays. Finally, two examples are given to illustrate the usefulness of our results.

Keywords: high-gain observer, nonlinear time-delay systems, global practical tracking, output feedback

1 Introduction

In this paper, we consider the problem of global practical output tracking via output feedback for the following uncertain time-delay SISO system:

$$\begin{aligned} \dot{x}_i &= x_{i+1} + \varphi_i\left(\theta^*(t), x, x(t-d_i)\right), \\ i &= 1, \ldots, n-1, \\ \dot{x}_n &= u + \varphi_n\left(\theta^*(t), x, x(t-d_n)\right), \\ y &= x_1, \end{aligned} \tag{1}$$

where $x = (x_1, \ldots, x_n)^T \in \Re^n$ is the system state, $u \in \Re$ and $y \in \Re$ are the system input and measured output, respectively. $\theta^*(t)$ is a continuous bounded mapping that represents a family of time-varying parameters or disturbances, and $d_i \geq 0, i = 1, \ldots, n$, are unknown time delays of the states. $x(t) = \Psi(t),\ t \in [-d, 0]$, $\Psi(t)$ is the initial condition, $d = \max\{d_1, d_2, \ldots, d_n\}$, and the functions φ_i, $i = 1, \ldots, n$, are continuous in the first argument and locally Lipschitz with respect to the other variables, which represent the system uncertainty and do not need knowing precisely.

Global practical output tracking problem has received a great deal of attention over the past decades. In particular, with the help of the technique of adding a power integrator [3, 4] and the idea of universal control, the problem of global practical tracking was solved for a class of inherently nonlinear systems by

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