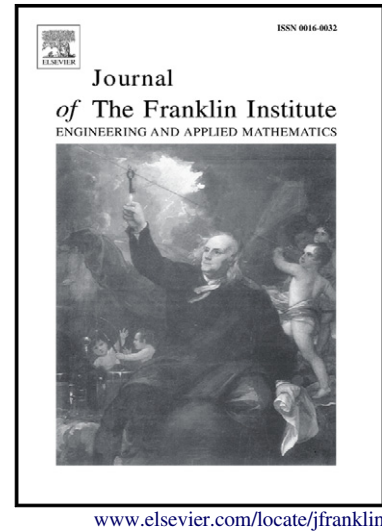


A Necessary and Sufficient Condition for Delay-Independent Stability of Linear Time-Varying Neutral Delay Systems

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Abstract

In this paper, stability analysis of linear time-varying neutral delay systems is considered. A necessary and sufficient condition for delay-independent global asymptotic stability of such systems is derived. Eventually, two examples are given in order to show the results established.

Keywords: delay-independent stability, linear time-varying neutral delay systems, fixed point theory.

1. Introduction

The time-delay phenomenon is encountered in various practical systems such as chemical systems, microwave oscillator, population dynamic model, circuit systems etc. Circuits with delay elements have become more important due to the increase in applications of VLSI systems. A real circuit model, such as a partial element equivalent circuit[1], can be represented as a linear neutral delay system:

$$y(t) = Ly(t) + My(t - \tau) + N y(t - \tau), \quad t \geq t_0 \quad (1)$$

$$y(t) = g(t), \quad t \leq t_0$$

where $y(t) \in \mathbb{R}^n$, with $\mathbb{R}$ denoting the set of all real numbers, and L, M , and N are known constant matrices of appropriate dimensions. In addition $g(t)$ is a continuous initial function, and τ is the time delay of the system. For system (1), contractivity and delay-independent asymptotic stability have been considered in [1,2,6], whereas [3-5] address delay-dependent stability of the system.

System (1) with parameter uncertainties becomes as following:

$$\begin{aligned} \dot{y}(t) &= (L + \Delta L(t))y(t) + (M + \Delta M(t))y(t - \tau(t)) + (N + \Delta N(t)) \dot{y}(t - \tau(t)), t \geq t_0 \\ y(t) &= g(t), t \leq t_0 \end{aligned} \quad (2)$$

where $\Delta L(t)$, $\Delta M(t)$, and $\Delta N(t)$ denote the bounded parameter uncertainties. In addition,

$0 \leq \tau(t) < \bar{\tau}$ and $\dot{\tau}(t) \leq d < 1$, where $\bar{\tau}$ and d are known constants. For system (2), asymptotic stability has been investigated in [7-12]. In the aforementioned references the Lyapunov's direct method has been used to obtain sufficient conditions for stability of systems (1) and (2).

Lyapunov's direct method has served successfully to provide sufficient conditions for stability of wide variety of systems. Nevertheless, using this method, six fundamental difficulties occur. First, it is an art to construct a Lyapunov function[13]. Second, conditions need to be placed on a parameter to be positive(or equivalently negative) most of the time[13]. Third, in so much of the work we need to ask

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