# An LMI Approach to $H_\infty$ Performance Analysis of Continuous-Time Systems with Two Additive Time-Varying Delays

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**Abstract.** This paper investigates the problem of $H_\infty$ performance analysis for continous–time systems with two additive time-varying delays in the state. Our objective is focused on stability analysis of a continuous system with two time-varying delays with an $H_\infty$ disturbance attenuation level $\gamma$. By exploiting Lyapunov-Krasovski functional and introducing free weighting matrix variables, LMI stability condition have been derived.

**Keywords:** *$H_\infty$ performance analysis; Linear Matrix Inequality (LMI); time delay systems.*

## 1 Introduction

Time delay is the property of a physical system by which the response to an applied force (action) is delayed in its effect. When information or energy is physically transmitted from one place to another, there is a delay associated with the transmission [1]. It is well known that the presence of time-delay is a source of instability [2]. Xia, et al. [3] presents some basic theories of stability and synthesis of systems with time-delay, in the form of $\dot{x}(t) = Ax(t) + A_d x(t - \tau(t))$, where $\tau(t)$ represents time-varying delay. Wu, et al. [4] presents a method referred to as the free-weighting-matrix (FWM) approach for the stability analysis and control synthesis of various classes of time-delay systems. In [5], a new model for time delay systems is proposed, that is $\dot{x}(t) = Ax(t) + A_d x(t - \tau_1(t) - \tau_2(t))$. The new model is motivated by practical situation in Networked Control Systems (NCSs), where $\tau_1(t)$ is the time-delay from sensor to the controller and $\tau_2(t)$ is the time-delay from controller to the actuator.

Motivated by stability condition for system with two delays in the state, derived in [6], in this paper we investigate conditions under which the continuous system with two time-varying delays in the state is asymptotically stable with an $H_\infty$ disturbance attenuation level $\gamma$. It is well known in systems and control

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