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FURTHER RESULTS ON NEW STABILITY ANALYSIS FOR UNCERTAIN NEUTRAL SYSTEMS WITH TIME-VARYING DELAY

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Abstract. *The delay-dependent and delay-independent conditions are proposed in order to assure the stability for the uncertain neutral system with interval time-varying delays. New additional nonnegative inequalities are introduced to improve the analysis. The solving schemes based on Linear Matrix Inequality (LMI) approach along with the selective examples are presented to demonstrate the improvements achieved.*

Keywords: Delay-dependent, Delay-independent, Uncertain neutral system, Linear matrix inequality

1. **Introduction.** Many practical applications such as the stabilization of aircraft, the biological and chemical engineering systems, the nuclear reactors and the dynamic models for population involve the time delay phenomenon which may cause instability or poor performance. A large number of previous research efforts [1-14] propose the stability and stabilization conditions to the systems involving time delay phenomena with the attempts to assure the stability of these various systems. In this respect, the practical applications with neutral systems include heat exchangers, the population ecology and the thermodynamic steam cycles. In order to describe the propagated speed of signals in these uncertain systems, the interval time-varying delays are introduced [7,8,14]. In [7,8], the delay-dependent criteria are introduced to guarantee the stability for the retarded systems with interval time-varying delay. In this paper, Leibniz-Newton formula along with the additional nonnegative inequalities is used to solve the time delay systems. The free weighting matrices and the new additional nonnegative inequalities introduced by this study serve the major contributions of this work. The proposed stability conditions show good improvements based on this approach. As the LMI approach has been shown as an efficient method in solving the control problems [15], this study adopts the LMI-based approach to solve the time delay problems. Several numerical examples are selected to demonstrate that the present method can significantly improve the allowed bounds.

The notation used throughout this paper is as follows. For a matrix A, we denote the transpose by A^T, spectral norm by $\|A\|$, symmetric positive (negative) definite by $A > 0$ $(A < 0)$. $A \le B$ denotes the condition that the matrix $B - A$ is symmetric positive and semi-definite. For a vector x, the Euclidean norm is defined as $\|x\|$. I denotes the identity matrix.

2. **Problem Statement and Preliminaries.** Consider the following uncertain neutral system with interval time-varying delays:

$$\dot{x}(t) = [A_0 + \Delta A_0(t)]\, x(t) + [A_1 + \Delta A_1(t)]\, x(t - h(t)) + [A_2 + \Delta A_2(t)]\, \dot{x}(t - \tau(t)),\ t \ge 0, \tag{1a}$$