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$\mathcal{L}_2$ GAIN ANALYSIS OF SWITCHED SYMMETRIC SYSTEMS WITH TIME DELAYS

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Abstract: In this paper, we study $\mathcal{L}_2$ gain property for a class of switched systems which are composed of a finite number of linear time-invariant (LTI) symmetric subsystems with time delays in system states. We show that when all subsystems have $\mathcal{L}_2$ gain γ in the sense of satisfying an LMI, the switched system has the same $\mathcal{L}_2$ gain γ under arbitrary switching. The key idea is to establish a common Lyapunov function for all subsystems in the sense of $\mathcal{L}_2$ gain.
Keywords: Switched symmetric system, time delay, arbitrary switching, $\mathcal{L}_2$ gain, common Lyapunov function, linear matrix inequality (LMI).
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1 Introduction

In the last two decades, there has been increasing interest in the stability analysis and controller design for switched systems; for recent progress and perspectives in the field of switched systems, see the survey papers [1, 2] and the references cited therein. It is agreed that there are three basic problems in stability and design of switched systems: (i) find conditions for stabilizability under arbitrary switching; (ii) identify the limited but useful class of stabilizing switching signals; and (iii) construct a stabilizing switching signal. There are many existing works on Problem (ii) and (iii). For example, Refs. [3]-[5] considered Problem (ii) using piecewise Lyapunov functions, and Refs. [6]-[8] considered Problem (ii) for switched systems with pairwise commutation or Lie-algebraic conditions. Ref. [9, 10] considered Problem (iii) by dividing the state space associated with appropriate switching depending on state, and Refs. [11]-[13] considered quadratic stabilization, which belongs to Problem (iii), for switched systems composed of a pair of unstable linear subsystems by using a linear stable combination of unstable subsystems. However, we see very few dealing with the first problem, though it is desirable to permit arbitrary switching in many real applications. Ref. [14] showed that when all subsystems are stable and commutative pairwise, the switched system is stable under arbitrary switching. There are some other results (e.g., [15])