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OPTIMAL CONTROL AND STATE ESTIMATION FOR IMPULSIVE SWITCHED SINGULAR SYSTEMS WITH TIME-DELAY

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Abstract. The main purpose of this paper is to address the problems of stability, stabilization and state estimation for impulsive switched singular systems with time delay. Here, the impulsive effects occur as a result of switching among the system states or modes. Firstly, some sufficient conditions on the exponential stability property of the system have been proposed. Secondly, an optimal feedback control for the system has been designed to guarantee the exponential stability of the closed-loop system. Thirdly, a Luenberger-type observer is designed to estimate the system states such that the corresponding closed-loop error system is exponentially stable. The stability results have been investigated by using the multiple Lyapunov functions along with the average-dwell time switching signal to organize the jumps among the system modes. Numerical examples with simulations are represented to further clarify the proposed methodology.

Keywords. Impulsive systems, switched systems, singular systems, delay systems, average dwell time, exponential stability, optimal control, state estimation.

1 Introduction

Singular systems, which are also referred to as descriptor systems or differential algebraic systems, have extensive applications in many practical systems such as electrical circuit networks ([1], [3]), power systems, aerospace engineering, economic systems ([1], [22]), and biological systems ([32]). A singular system model is mathematically formulated as a set of coupled differential and algebraic equations, which includes information on the static as well as dynamic constraints of a real plant. Singular systems have many special features such as regularity, impulse terms, consistent initial condition and so on, which are not found in nonsingular (or normal) systems. On the other hand, many fundamental notions and interesting results for normal systems have been extended to singular systems, for instance, the Lyapunov stability, controbility, observability, and optimal control ([2], [3], [4], [7], [20]).

Time delay is unavoidable in many physical systems whose future state depends not only on the present state but also on the past state. Therefore, physical systems can be modeled more realistically by including some of the historical values of the system states. However, the study of systems with