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COMPOSITE OPTIMAL CONTROL FOR SINGULARLY PERTURBED SYSTEMS WITH TIME-DELAY VIA SUCCESSIVE APPROXIMATION APPROACH

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Abstract. The quadratic optimal control problem for linear time-delay singularly perturbed systems is investigated via successive approximation approach (SAA) in this paper. Based on singular perturbation theory, the system is decomposed into two subsystems of a slow-time scale and a fast-time scale. The slow-time scale time-delay optimal control problem is transformed first into a sequence of nonhomogeneous linear two-point boundary value (TPBV) problems without time-delay and time-advance terms. By using the SAA, the optimal control law of the slow sub-system with time-delay is obtained. Further, the composite control law of the original problem is given. The composite control law consists of non-delay feedback terms and a time-delay compensation term which is the limit of the solution sequence of the adjoint equations. Simulation examples indicate that the SAA is valid and easy to implement.

Keywords. Singularly perturbed systems, time-delay systems, optimal control, successive approximation approach.

AMS (MOS) subject classification: 49N35

1 Introduction

It is well known that time-delay is often encountered in various practical systems, such as communication systems, hydraulic, economic systems, chemical processes, and rolling mill systems, et.al. The analysis and design of time-delay systems has received considerable attention from the research community, and some research results have been obtained in application as well as theory fields. For instances, Han [1] investigated the stability for a class of uncertain linear neutral systems and derived some delay-dependent stability criteria, and the result was improved by using the discretized Lyapunov functional method in Han et al. [2]. Jiang and Han [3] studied the H_∞ control for interval time-varying delay systems, and obtained a bound of the optimal H_∞ performance index; Kolmanovsky and Maizenberg [4] investigated a finite-horizon optimal control problem for randomly varying time-delay systems.