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NEAR-OPTIMAL CONTROL FOR SINGULARLY PERTURBED BILINEAR SYSTEMS USING THE METHOD OF SUCCESSIVE APPROXIMATIONS

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Abstract. In this paper near-optimal control with a quadratic performance index for singularly perturbed bilinear systems is considered. The proposed algorithm decomposes the full order system into the slow and fast subsystems, and optimal control laws for the corresponding subsystems are obtained by using the successive approximation of a sequence of Lyapunov equations. On the basis of composition we obtain the global near-optimal control law, which avoids the ill-defined numerical problem, reduces the size of computations, and speeds up the optimization process by solving a sequence of Lyapunov equations. A numerical example is presented to verify the proposed algorithm.

Keywords. Bilinear system, Optimal control, Singular perturbation, Successive approximation, Composite Control

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1 Introduction

Physical systems are inherently nonlinear in nature. Also, many real physical systems are described by bilinear models. Detailed reviews of bilinear systems and their control design methods can be found in [9]. But for the general regulation problem of bilinear systems, with the exception of simplest cases, there is no optimal control in the explicit feedback form [2]. Many researchers present numerical methods for finding optimal controls for the bilinear system. A common approach is to numerically solve for the state and costate equations from a Hamiltonian formulation of the optimal control problem.

Singularly perturbed systems having two or multi time-scale have been studied by many researchers [1][2][8][10]. In the case of optimal control problem, the control algorithm for the full order system leads an ill-defined numerical problem. To avoid this difficulty, the full system is decomposed into slow and fast subsystems, and optimal control laws are designed for each subsystem. Thus the optimal control law for the original system is obtained by composing these optimal control laws. But the decomposed subsystems are also bilinear systems, which means that there is no optimal control in the explicit feedback form.