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COMPOSITE CONTROL FOR SINGULARLY PERTURBED NONLINEAR SYSTEMS VIA SUCCESSIVE GALERKIN APPROXIMATION

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Abstract. This paper presents a new algorithm of the closed-loop composite control for singularly perturbed nonlinear systems with respect to performance criteria, using the successive Galerkin approximation(SGA). The singularly perturbed nonlinear system is decomposed into two subsystems of a slow-time scale and a fast-time scale by the singular perturbation theory, and two optimal control laws are obtained to each subsystem using the SGA method. The composite control law that consists of two optimal control laws of each subsystem is designed. One of the purposes of this paper is to design the closed-loop composite control law for the singularly perturbed nonlinear systems via the SGA method. The other is to reduce the computational complexity when the SGA method is applied to the high order systems.
Keywords. Composite control, Near-optimal control, Nonlinear system, Singular perturbation, Successive Galerkin Approximation.
AMS (MOS) subject classification: 93C10, 93C70, 49J15, 49M15

1 Introduction

Many real physical systems are described by singularly perturbed nonlinear systems [7],[10],[12]. The singularly perturbed systems include two or multi time scales and have been studied by many researchers [2],[6],[7],[8],[12]. In the class of optimal control [11], design of the control law for the singularly perturbed systems has ill-defined numerical problems [1],[2],[8],[12]. To avoid these problems, the full order system is decomposed into reduced slow and fast subsystems, and optimal control laws are designed for each subsystem. Thus, the near-optimal composite control law consists of two optimal sub-control laws [1],[2],[8],[12]. But, the solution of Hamilton-Jacobi-Bellman(HJB) equation for nonlinear systems can be hardly found, and thus we find the approximated solutions using successive Galerkin approximation(SGA) [4],[5]. However, the SGA method has the difficulty that is the complexity of computations according to order of system, and thus the full order system is decomposed into the reduced order subsystems. The optimal sub-control laws are designed for singularly perturbed nonlinear systems using the SGA method, respectively. The closed-loop composite control law consists of two optimal sub-control laws of each subsystem.
The purpose of this paper is to design the closed-loop composite control laws for singularly perturbed nonlinear systems using the SGA method. In order