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ROBUST STABILIZATION AND PASSIVITY OF UNCERTAIN NONLINEAR SYSTEMS

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Abstract. This paper is devoted to the robust stabilization and passivity of general uncertain nonlinear systems. It is first proved that the unforced system has a unique local solution with any initial value in some neighborhood of the origin. Some properties of robust passive systems are obtained. Based on these properties, it is verified that under some conditions robust passivity of the uncertain system implies the zero-state detectability, which, together with robust passivity, can lead to robust stabilization of the uncertain nonlinear system. In addition, a C^1 state feedback controller is derived on the basis of the solution of an equation. Finally, the effectiveness of the proposed control law is demonstrated via simulations.

Keywords. Nonlinear systems, uncertainty, robust stabilization, robust passivity, z ero-state detectability.

AMS (MOS) subject classification: 93B52, 34D99.

1 Introduction

The stabilization problem is hard and essential in nonlinear systems([5][6][9] [17][18]). Many kinds of controller designing methods have been presented in the past decades, such as Lyapunov redesign, feedback linearization, sliding mode, backstepping and so on. In particular, passivity technique has also been applied to the stabilization of nonlinear systems. On the basis of passivity approach, paper [1] reported a sufficient condition for an affine nonlinear system being equivalent to a passive system via state feedback. Then this technique has been extended to continuous-time (resp. discrete-time) general nonlinear systems([2][10][11][12]). If the uncertain nonlinear systems are robust minimum phase with relative degree one, then the closed-loop systems can be robust strictly passive by smooth state feedbacks[13]. In succession, a lot of results have been obtained for the relation between the stability and the passivity([4][10][13][14][16]). For example, based on the theory of passivity, sufficient conditions for uncertain nonlinear systems to be globally asymptotically stable via state feedback are given[4].