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H_∞ CONTROLLER DESIGN FOR A CLASS OF SISO NONLINEAR STOCHASTIC SYSTEMS WITHOUT SOLVING HJIS

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Abstract. *The purpose of this paper is to provide an H_∞ control to avoid solving any Hamilton-Jacobi Inequalities (HJIs) for a class of single-input single-output (SISO) nonlinear stochastic systems. By transforming the stochastic system into an interconnected system with different structure case, the state feedback H_∞ control problem is studied by using the almost disturbance decoupling technique, or γ-dissipative theory. The H_∞ controller is designed directly by solving a Lyapunov-like inequality or Stochastic Lur'e equations instead of HJIs.*
Keywords: H_∞ control, Nonlinear systems, Stochastic systems, Almost disturbance decoupling

1. **Introduction.** The H_∞ optimal control problem, since the foundation work of [14], has been extensively studied in both theory and practical applications; see, e.g., [15] and [18-21]. In 1990s, as to the deterministic nonlinear system case, the H_∞ control problem has been addressed by several investigators using the notions of dissipativity and geometric method; see [1-3] and [7, 9, 13]. One important topic is called nonlinear H_∞ almost disturbance decoupling problem, which provides a parameterized state feedback H_∞ control. [2] considered this problem for minimum-phase nonlinear systems with a triangular structure, which was also considered in [16] for a larger class of systems. The problem of H_∞ almost disturbance decoupling with internal stability for a class of non-minimum phase SISO nonlinear systems was studied in [17]. However, as to the stochastic system case, there is still little work dealing with this problem.

In recent years, due to great many applications of stochastic Itô systems in real world [8], the study on H_∞ control design for stochastic Itô systems has received a great deal of attention; see the monographs [11] and [12]. A good introduction to general linear stochastic H_∞ control can be found in [4], where a stochastic bounded real lemmas (SBRL) was given in terms of linear matrix inequalities (LMIs). Recently, [5] and [10] developed the nonlinear H_∞ theory from the dissipation point of view, which showed that the nonlinear state-feedback H_∞ controller design can be obtained via solving a corresponding HJE or HJI. However, compared with the deterministic case, the HJE (HJI) associated with the nonlinear stochastic H_∞ control is a second-order (not first-order) nonlinear partial differential equation (inequality) due to the effect of the diffusion terms, which makes the problem more complex. Generally speaking, it is very difficult to solve the second-order