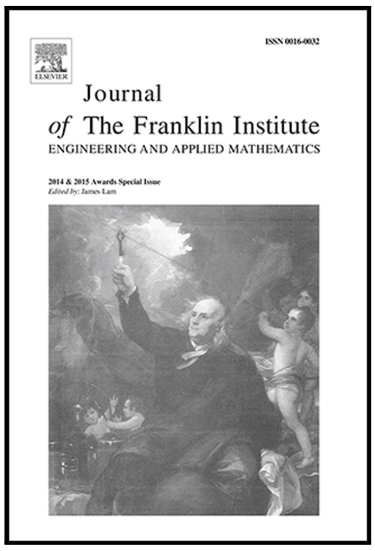

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Dissipative Observers for Discrete-Time Nonlinear Systems

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Abstract

This paper addresses the problem of designing a state observer for a class of nonlinear discrete-time systems using the dissipativity theory. We show that the dissipative observation methodology, originally proposed by one of the authors for continuous-time nonlinear systems, can be extended to the discrete-time case. For constructing a convergent observer, the methodology is applied to the nonlinear estimation error dynamics, which is decomposed into a discrete-time LTI subsystem in the forward loop, connected to a time-varying static nonlinearity in the feedback loop. In order to assure asymptotic stability of the closed-loop, complementary dissipativity conditions are imposed on each of the subsystems: (i) the static nonlinearity is required to be dissipative with respect to a quadratic supply rate, and (ii) the observer gains are designed such that the LTI system is dissipative with respect to a complementary supply rate. As in the continuous time framework, the proposed method includes as special cases, unifies and generalizes some observer design methods proposed previously in the literature. A great advantage of the Dissipative Observer Design Method proposed here is that it leads to Matrix Inequalities for the design of the observer gains, and these can be usually converted into Linear Matrix Inequalities (LMI's). The results are illustrated using Chua's Chaotic system.

Keywords: Dissipative Observer; Discrete Time Systems; Linear Matrix Inequalities

1. Introduction

Estimating on-line unmeasured variables of a dynamical system is one of the fundamental problems in automatic control, and the design of state observers is of growing interest [1, 2]. Since there is no general theory for the design of state observers for nonlinear systems, in the last decades different methods have been proposed for different classes of continuous time systems, under different observation scenarios. We find, for example, the High-Gain methodology [3, 4, 5, 6], the Lipschitz approaches [7, 8, 9, 10], Circle-criterion designs [11, 12], the dissipative method [13, 14, 15], interval observers [16, 17, 18, 19], and the sliding-mode observers [20, 21, 22].

Many design methods have been also presented for different classes of discrete-time nonlinear systems. One natural approach deals with the transformation by nonlinear coordinate

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