QSS-DISSIPATIVITY AND FEEDBACK
QSS-PASSIVITY OF NONLINEAR DISCRETE-TIME SYSTEMS

Eva María Navarro-López
Programa de Investigación en Matemáticas Aplicadas y Computación
Instituto Mexicano del Petróleo
Eje Central Lázaro Cárdenas, 152, ed. 18, planta primera, cub.106
A.P. 14-805, 07730 México, D.F., México

Abstract. Dissipativity and feedback passivity properties in nonlinear multiple-input multiple-output (MIMO) discrete-time systems are examined. Three main results are presented. First, necessary and sufficient conditions for the characterization of a class of dissipative nonlinear MIMO discrete-time systems in general form are proposed. The class of dissipativity treated is referred to as Quadratic Storage Supply-dissipativity. The conditions existing in the literature, addressed as Kalman-Yakubovich-Popov conditions, for the dissipative, passive or lossless cases, are derived from the proposed dissipativity characterization. Second, some relative degree-related properties of nonlinear MIMO Quadratic Storage-passive systems which are affine in the input are stated. Third, the problem of rendering a nonlinear affine-in-input MIMO discrete-time system passive using the properties of the relative degree and zero dynamics is analyzed. Quadratic Storage-passive systems are considered. The feedback passivity methodology is illustrated by means of a class of systems modelling different discrete dynamics with physical interpretation.

Keywords. Discrete-time systems, Nonlinear systems, Feedback passivity, Dissipativity, Feedback stabilization.

AMS (MOS) subject classification: 37N35, 93C10, 93C55, 93D05, 93B52.

1 Introduction

Two main problems will be considered in this paper. On the one hand, the proposal for a class of nonlinear discrete-time systems of what is referred to as Kalman-Yakubovich-Popov (KYP) conditions, that is, necessary and sufficient conditions for a system to meet in order to be dissipative or passive. On the other hand, the problem of rendering a system passive by means of a static state feedback control law. The dissipativity approach followed in this paper is the one based on the state-space dynamical representation and the use of storage and supply functions.

Dissipative (passive) systems present highly desirable properties which may simplify systems analysis and control design [7]. The concepts of dissipativity and passivity have been widely used for the stability analysis of continuous-time nonlinear systems and successfully applied in order to study