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

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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.
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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 dymamical 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