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Stability Conditions for a Class of Nonlinear Time Delay Systems

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Abstract: In this paper, stability analysis for a class of nonlinear time delay system is done. A state space representation of the class of system under consideration is used and a transformation is carried out to represent the system by an arrow form matrix. Taking advantage of this representation and applying the Kotelyanski lemma in combination with properties of M-matrices, some new sufficient stability conditions are determined. An illustrative example is presented to show the effectiveness of the proposed approach.

Keywords: *nonlinear time delay systems; arrow matrix; stability analysis.*

Mathematics Subject Classification (2010): 34K20.

1 Introduction

Time delay exists in many practical systems. This includes chemical processes, teleoperators, mechanical systems, network control systems etc. see [2,3,8,11]. The delay can be an inherent part of the dynamics of the system or can be a result of actuators and sensors used and the time needed for transmission of control signals. Presence of delay complicates the analysis of such systems and can even cause instability [6,10,11]. In many situations industrial models have to represent nonlinear phenomena for the delay or the system itself. This is justified by the insufficiency of the first order linear approximations to explain the typically nonlinear problem of instability linked to excessive initial conditions or perturbations. Difficulties are greater when delays appear in nonlinear systems, see [1,3–5] for an excellent exposition of nonlinear delay equations. For all these reasons, there has been an extensive literature on stability of time delay systems [7,19,21]. In this

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