Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Applications & Algorithms* **14 (2007)** 749-752
 http://www.watam.org

COMMENTS ON "NECESSARY AND SUFFICIENT VERTEX SOLUTIONS FOR ROBUST STABILITY ANALYSIS OF FAMILIES OF LINEAR STATE SPACE SYSTEMS

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Abstract. The paper [1] addresses the problem of ascertaining the Hurwitz stability of a polytope of matrices and provides necessary and sufficient conditions involving the analysis of the spectrum of a finite number of matrices. This note points out some flaws in the proof of the previous result, which turns out to be incorrect in the present form.

Keywords. Hurwitz stability, spectrum, polytope of matrices, linear systems, robustness.

1 Introduction

In a recent paper [1], the author finds necessary and sufficient conditions for ascertaining the Hurwitz stability of a polytope of matrices

$$\mathcal{A} = \left\{ A = \sum_{i=1}^{h} \alpha_i A_i, \quad \alpha_i \geq 0, \quad \sum_{i=1}^{h} \alpha_i = 1 \right\}.$$

Yedavalli's algorithm is based on the analysis of the spectrum of a finite number of special matrices, namely virtual center matrices and Kronecker Nonsingularity Matrices (KNMs). They are built by means of the Kronecker-Lyapunov (KL) matrices associated to the vertex matrices A_i. In what follows they are sometimes referred to as 'dagger' transformed matrices. KL matrices have some special properties, that is if a matrix $A \in \mathbb{R}^{n\times n}$ has eigenvalues λ_i $i = 1, \ldots, n$, then the associated KL matrix L_a has the following eigenvalues: $\mu_k = \lambda_i + \lambda_j$, with $i = 1, \ldots, n$, $j = 1, \ldots, i$, $k = 1, \ldots, m$, and $m = \frac{1}{2}n(n + 1)$. This property implies that, for each couple of complex conjugate eigenvalues $\lambda = a \pm jb$ of A, there is a real eigenvalue in L_a whose value is $\mu = 2a$. Therefore, a problem of stability for a matrix pencil of matrices in the original space is converted in a singularity problem for the matrix pencil of the 'dagger' transformed matrices.

The aim of this note is to show, by means of some counterexamples, that the proof of the previous result presents some errors.