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Some recent results on the stability of linear time varying systems

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Abstract. Some theorems derived recently by the authors on the stability of multidimensional linear time varying systems are reported in this paper. To begin with, criteria based on Liapunov's direct method are stated. These are followed by conditions on the asymptotic behaviour and boundedness of solutions. Finally, L_2 and L_∞ stabilities of these systems are discussed. In conclusion, mention is made of some of the problems in aerospace engineering to which these theorems have been applied.

Keywords. Stability; linear time varying systems; Liapunov's direct method.

1. Introduction

Mathematical equations describing physical systems could be classified, in the order of increasing complexity, into

linear time invariant (LTI);
nonlinear time invariant (NLTI);
linear time variant (LTV);
nonlinear time variant (NLTV).

Most of these equations are not amenable to closed form solution. Of the aforementioned categories, closed form solutions in terms of the existing elementary functions exist only for LTI systems. Nonavailability of explicit solutions was the primary motivation for the development of the qualitative theory of differential equations, which determine the properties of solutions without explicitly solving the equations.

The present study was motivated by the recent trend towards building very large, complex space structures which require precise control. During deployment of large structures from space stations/platforms, the system parameters vary rapidly and arbitrarily. The equations encountered are typically of the form

$$M(t)q''(t)+G(t)q'(t)+K(t)q(t)=P(t)w(t), \tag{1}$$