Investigation of Stability of Differential Algebraic Equations Using Their Perturbed Analogue

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Abstract: Consider the problem

$$\Lambda_1 x := A(t)\dot{x} + B(t)x = \phi(t),\ t \in T_\infty = [\alpha, \infty),\ x(\alpha) = a, \tag{1}$$

where $A(t),\ B(t)$ are $(n \times n)$-matrices, $x \equiv x(t)$ is a desired vector-function, $\phi(t)$ is a given vector-function, a is a given scalar vector from $\mathbf{R}^n$, $\dot{} = d/dt$.

It is assumed that the initial data is sufficiently smooth and

$$\det A(t) \equiv 0,\ t \in T_\infty, \tag{2}$$

Systems of the form (1) satisfying condition (2) are commonly called differential algebraic equations (DAEs). They play an important role in various applications.

Together with the problem (1), (2) consider

$$[A(t) + \varepsilon B(t)]\dot{x}_\varepsilon + B(t)x_\epsilon = \phi(t),\ \varepsilon > 0,\ t \in T,\ x_\varepsilon(\alpha) = a,. \tag{3}$$

If, starting with some $\varepsilon \leq \varepsilon_0,\ \det[A(t) + \varepsilon B(t)] \neq 0\ \forall t \in T$, then system (3) can be resolved with respect to derivatives

$$\dot{x}_\varepsilon = \mathcal{A}_\varepsilon(t)x_\varepsilon + \phi_\varepsilon(t), \quad t \in T, x_\varepsilon(\alpha) = a, \tag{4}$$

where $\mathcal{A}_\varepsilon(t) = -[A(t) + \varepsilon B(t)]^{-1}B(t),\ \phi_\varepsilon(t) = [A(t) + \varepsilon B(t)]^{-1}\phi(t)$.

In this talk we discuss connections between dynamics properties of system (1) and system (4).

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