Regularization of linear time-varying delay differential-algebraic equations

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Differential-algebraic equations (DAEs) are a widely accepted tool for modeling and simulation of constrained dynamical systems. Applications, such as multibody systems, electrical circuit simulation or fluid dynamics, that may be modeled as DAE often feature hereditary effects caused by internal time delays or delayed feedback control. This leads to so called delay DAEs (DDAEs).

In this talk we show that DDAEs are essentially ill-posed in general and hence require a suitable regularization prior to the numerical treatment. The ill-posedness for DAEs is typically classified by of one of many index concepts [1], e. g. the strangeness index [2]. While this translates to DDAEs, numerical algorithms may additionally suffer from hidden noncausal constraints. In this context, the shift index [3] characterizes the degree of noncausality of the DDAE. We present a novel regularization methodology for linear time-varying DDAEs, which is a generalization of the strangeness-free reformulation procedure to DDAEs and allows for an efficient computation of the strangeness and shift index. The resulting regularized system is well-posed and suitable for classical numerical algorithms like the Bellmann method of steps (cf. [4]).

References

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