Coupled error propagation in terms of vector valued error terms

Martin Arnold (Martin Luther University Halle-Wittenberg)

Projectors are a useful tool to study certain components of a differential-algebraic equation separately from the other ones. We use them to analyse the convergence of generalized-α time integration methods for constrained mechanical systems with rank-deficient mass matrix. This convergence analysis is based on a coupled error propagation in terms of nine different vector valued error terms that may be investigated by a novel error recursion scheme for vector valued error terms.

The global error of generalized-α methods is seen to be composed of a second order error term resulting from the accumulation of local truncation errors and an additional error term that describes the influence of starting values. This additional error term may be of lower order but will be damped out after a short transient phase. It is characterized by powers of a 7×7 error amplification matrix $\mathbf{T}_z$ that is block-triangular with diagonal blocks of size 3×3, 2×2, 1×1 and 1×1. The sequence $(\mathbf{T}_z^n)_{n \geq 0}$ tends to zero since all eigenvalues of $\mathbf{T}_z$ are inside the unit circle in the complex plane. Nevertheless, $\|\mathbf{T}_z^n\|_2$ may be much larger than one in a transient phase since the 3×3 and 2×2 diagonal blocks are non-normal matrices.