Overlapping dynamic iteration for differential-algebraic systems

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Dynamic iteration (or waveform relaxation) methods are a very general framework for the modular time integration of coupled differential equations. In each step of iteration the large coupled system is decoupled in a set of smaller subsystems that may be solved independently from each other.

If the subsystems are coupled by *constraints* then each constraint has to be assigned to one of the subsystems. Often it makes sense to assign one and the same constraint to more than one subsystem such that the subsystems overlap. For a unified presentation of all these approaches the well known concept of overlapping dynamic iteration methods is generalized from ODE theory to coupled differential-algebraic systems. It will be shown that the stability of the dynamic iteration method and its speed of convergence depend strongly on the partitioning of the constraints and on the choice of certain weighting matrices.

In a practical application the dynamic iteration is typically not applied at once to the complete time interval of interest but only to smaller subintervals (*windows*). The integration starts with the initial values and is then continued stepping from window to window. Here, an additional contractivity condition is given that guarantees a stable error propagation during integration. For overlapping methods the weighting matrices may be chosen such that this contractivity condition is always satisfied.

The theoretical results are illustrated by numerical examples from computational mechanics.