Time integration in systems with instabilities

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ABSTRACT

The simulation of complex systems is important in many fields of science and in real-world applications. Time integration, if not designed properly, can return misleading numerical solutions (unstable numerical solutions for what is in fact a stable system or vice versa). To understand the cause of these numerical artefacts, we construct stability charts that shed light on transitions between stable and unstable behaviour simulation. Our goal is to understand the stability properties of the simulated representation of the continuous system. We will achieve this goal by comparing the stability conditions of the discretized system with those of the continuous system to analyse algorithmic robustness.

Finally, we propose a robust time integration scheme for nonlinear dynamic analysis with particular application to snap-through buckling of shallow arches. The algorithm is a composite method that consists of three sub-steps. Optimal values of the algorithmic parameters are determined to satisfy stability criteria and minimize damping. The proposed method is accurate, numerically stable, and efficient as demonstrated through several examples involving large deformation, large displacement and large rotation presented in this talk.