Reduced model for the crash simulation

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ABSTRACT

The car crash simulation contains of many complexities: the geometrical and material nonlinearities, the contact management and the numerical dispersion. In order to represent well all local physical phenomenon (plasticity, spot-weld crack…), a crash model needs a fine mesh (from 5 to 20 M finite elements for a whole vehicle). The crash solver using explicit algorithm takes small time step because of the Courant's condition. Consequently, it takes time for the car crash simulation (till 24 hours), particularly in the context of automotive engineering: we are interested in a reduced model which cuts back the total cost of an optimization study. Our aim does not concern the reduction of a single simulation (of which the dimension is only the product of time and space) but that of parametric domain (product of time, space and design parameters). More precisely, we hope a reduced model not only to reconstruct an already done simulation but to estimate a new simulation interpolated between existing simulation(s) in a Design Of Experiments. Recently, lot of teams have studied reduced models by Reduced Basis, POD [1] [2]or PGD [3] but until now no one have achieved for a car crash model even a small subsystem, both in intrusive and nonintrusive methods.

In this presentation, we would like to present:

- The specifications of the crash simulation in a design space through two use-cases: a BoxBeam and a Tbeam which represent side member (the most important part for energy absorption) and the engine;
- Our context of reduction. The final aim is to divide at least by two the cost of an optimization study. The Design Of Experiments is essential;
- The use of the SVD (Singular Value Decomposition) to see if a reduced model can detect some particularities in our case, for example the symmetry when we vary parameters;
- Our recent results on small use-cases (BoxBeam and TBeam) and an automotive subsystem.

Our current research themes for model reduction are:

- CUR decomposition – a new algorithm [4];
- Krigeage [5];
- Random matrix [6];
- Dynamic Time Warping [7];
- Higher-Order Singular Value Decomposition [8].

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