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X-FEM explicit dynamics for large deformation of foam seats

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ABSTRACT

Finite Element Method is now currently used in automotive industry to compute complete car crash. However, some bodies of the car, such as the seat, still remain difficult to calculate. During the crash, soft foam seats are subjected to very large strains. The Lagragian description of the motion leads to excessive distorsions of the mesh which makes the calculation abort. The most classical solution is to remesh the part during the dynamic calculation. In order to be sure that the new mesh is not distorted, ones have to remesh the part in its deformed configuration. These methods are not very easy because the new mesh has to follow the deformed geometry.
In this context, the use of the X-FEM Method combined with level-set method seems to be revelant. In this approach, the mesh does not need to conform to the interface, external boundaries are simply described by the iso-zero of a level set function. The remeshing work becomes much more easier, we can choose a regular grid as the new mesh.
In order to continue the calculation on this new grid, we first need to locate the position of the deformed part on the grid. This is done by evaluating the iso-zero of the deformed interface describing the part. Then we have to transfer all state variables from the old distorted mesh to the new regular grid. We show that in the case of hyperelastic material in dynamics, we only have to transfer displacement and velocity fields. We propose to use specific algorithms which take advantage of the regularity of the new mesh. Numerical examples are presented here to illustrate the efficiency of the method.
An another important phenomenon to simulate is the contact between the human body and the seat. We use the penalty method to model contact. This classical algorithm has to be adapted to deal with unmeshed contact surfaces represented by level-set. These special features are presented here with several examples.

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