A fully Eulerian approach for fluid-structure interactions with contact

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This talk is devoted to the simulation of fluid-structure interaction problems with large solid displacements up to contact of different solids or a solid with a wall. To be able to deal with the topology changes arising in the fluid domain, we adopt a monolithic fully Eulerian approach.

A monolithic Eulerian approach poses several challenges for a finite element discretisation, as the solid and the interface move over mesh lines and the solution is not smooth across the interface. If the position of the interface is not considered in the discretisation, severe stability and accuracy issues might arise. In this talk, we present accurate discretisation schemes in space and time as well as a robust numerical framework to circumvent these issues. The basic idea of the discretisation in both space and time is to resolve the interface locally within the discretisation. The spatial discretisation uses a fixed patch mesh independent of the interface location and a local refinement that takes into account the interface. For time discretisation, we develop a time-stepping scheme based on a Galerkin ansatz in time that uses space-time trajectories that follow the movement of the interface.

We apply the numerical framework to the problem of a bouncing ball including the contact with the ground and show numerical results of a ball bouncing down some stairs.