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Interface thickness control for multiphase calculation

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Anisotropic adaptive meshing can be used for solving multiphase flow problem with clear advantages. We refer to the use of a heterogeneous Navier-Stokes solver coupled with a transport equation for the phase descriptor; here the local convected level set function is used. It is possible to overtake the discontinuity appearing at the interface by using regularization. The regularization parameter can be seen as the thickness or the resolution of the interface. It will be shown that using adaptivity, one can choose a priori the resolution of the thickness to be very small which leads to very sharp interfaces, favorable for simulating turbulent multiphase flow.

The purpose of this presentation is to show that combining stabilized finite element solvers and automatic tools to build adapted unstructured anisotropic meshes with highly stretched elements gives rise to a new way for doing accurate numerical simulation [1, 2].

The mesh technology is based on a local topological modification kernel using a minimum volume principle to conform a mesh. The element shape and size optimisation process is extended to anisotropy using a metric field. This metric is built directly at the node using a new a posteriori estimate based on the length distribution tensor approach and the associated edge based error analysis. Recently, the proposed error analysis has been extended to time adaptation using the same technique and providing automatically time steps or time slabs of adapted meshes [3]. Several numerical examples and applications will be given involving high performance computing and showing that the proposed methods scale very well up to ~100 000 of cores allowing to simulate accurately different physical problems such as bubble and droplet formations with surface tension, free surface flow for hydraulic problems, interface capturing for phase change problems, and finally structure developments in computational material physics.

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