The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Simulating wetting of geometrically complex surfaces using the unstructured Volume-of-Fluid method

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Keywords: *wetting, geometrically complex surface, unstructured volume-of-fluid (VOF)*

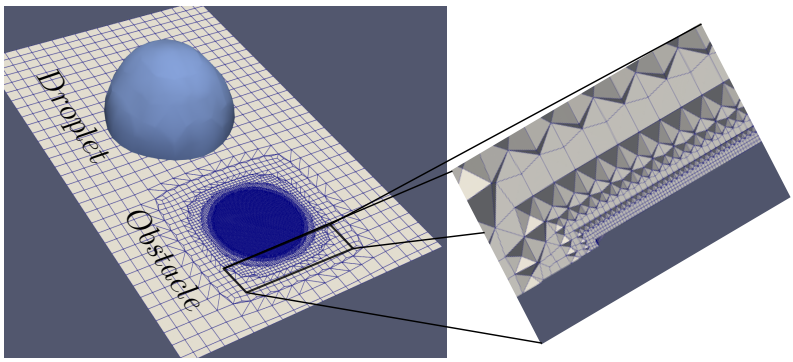

Figure 1: Sliding droplet over an obstacle, with mesh refined around the obstacle

Wetting of geometrically complex surfaces, a research focus of the Collaborative Research Center 1194 at TU Darmstadt, requires unstructured domain discretization (meshes) that maps to geometrically complex boundaries with second-order accuracy (e.g. obstacle in Fig. 1). The unstructured VOF method [1] is chosen here because of its inherent volume conservation property. However, approximating the surface tension force is still challenging for the VOF method, especially on unstructured meshes, and even more so near walls.

We are investigating droplets sliding across heterogeneous (hydrophobic/hydrophilic) surfaces having geometrical/chemical obstacles (see Fig. 1), using unstructured plicRDF VOF method [3] in OpenFOAM, which demonstrates convergent behavior of the advected contact angle, a specific verification case introduced in [2] on structured meshes. The numerical method isoAdvector [4], implemented in OpenFOAM for the advection of interface with the plicRDF reconstruction scheme [3], achieves 2^{nd} order convergence for a small enough time step size. The method's behavior near the wall and the influence of contact angle boundary conditions are investigated in this work using the droplet spreading validation case. A deeper insight into wetting of geometrically complex heterogeneous surfaces is obtained with the help of a direct comparison with experiments.

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