MSc-project: MULTI-SCALE MODELING OF PARTICLE-MOTION IN FLUID

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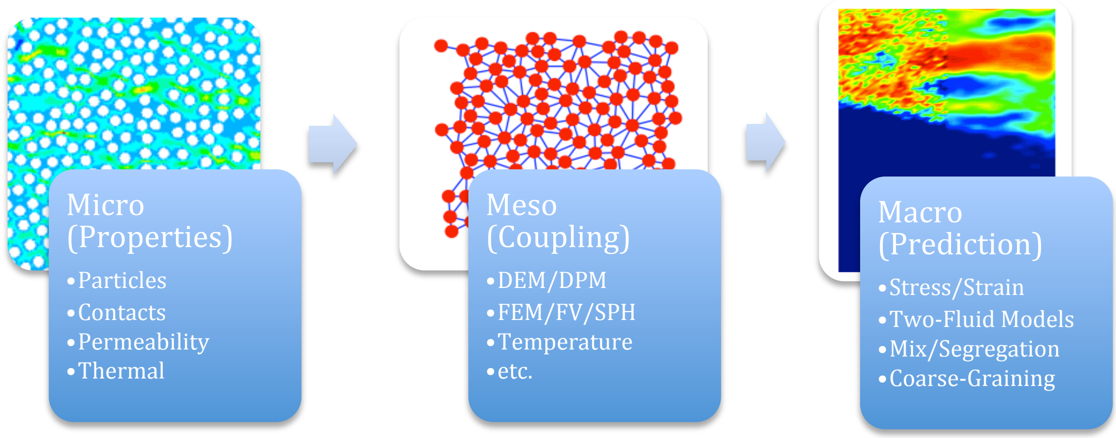
Project-**goal** is a meso-scale model, see Fig. 1, including (i) micro-scale details oft he particle-fluid interaction, (ii) dynamic, three-dimensional, two-way coupled meso-scale modeling of particle transport, and (iii) a quantitative prediction of large-scale **applications** and phenomena as, e.g., fluidized beds & reactors, bio-mechanical flows, offshore sand-transport processes, by using reduced continuum models.

Fig. 1: Meso-scale-model schematic: (Left) Finely resolved fluid-particle simulation; (Mid) meso-scale DDT (dynamic Delaunay triangulation) simulation; (right) macro-scale density field of the particle phase suspended in the water (at two different length scales).



The new technical idea is a monolithic algorithm that uses the same data-structures and algorithms for the fluid as for the particle phase. This can be achieved in two-ways, both start from the particle discrete element method (DEM): (1) use a dynamic Delaunay triangulation (DDT) to form a grid that is attached and based on the particle centers and moves with them – and then is used to solve the fluid/hydromechanic equations using finite element methods (FEM) or Computational Fluid Dynamics (CFD); (2) use the particle based smooth-particle hydrodynamics (SPH) method that is easily added to a particle code and allows to solve the fluid Navier Stokes equations.
Two-phase-flow simulations are an important tool in process engineering [1] and get more and more used for process simulations. More recently, meso-scale methods that combine DEM-DDT-FEM [2], or DEM-SPH [3] have been developed in the group MSM, CTW, UTwente. Know-how on finely resolved simulations of the fluid through particles [4] is complemented by micro-macro methods as „coarse-graning" from DEM- to continuum-data [5], which can enter macroscopic models for large-scale flow predicitons. Finally, the existence of strongly different sized particles is accounted for by modern, efficient hierarchical grid methods that allow to model realistic, relevant systems.

Literature:

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