Technische Universität Dresden

Institut für Strömungsmechanik, Professur für Strömungsmechanik

Vortrag

On high-fidelity simulations of particle-laden flows and attempts to make it computationally feasible

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Particle-laden flows occur across a broad spectrum of natural and industrial processes, including sediment transport, fluidization, slurry handling, and catalytic coating deposition. Among available simulation approaches, particle-resolved direct numerical simulation (PR-DNS) based on the computational fluid dynamics-discrete element method (CFD-DEM) framework provides the highest level of physical fidelity, as fluid-particle interactions are resolved directly and particle motion is computed from first principles. However, the predictive accuracy of PR-DNS is accompanied by prohibitive computational costs, which currently limit its practical applicability to small-scale systems. In the talk, we will present an overview of an in-house PR-DNS solver based on a hybrid fictitious-domain immersed boundary (HFDIB) method combined with DEM capable of treating arbitrarily shaped particles represented by polyhedral geometries. Then, three complementary strategies aimed at reducing the computational burden of PR simulations are discussed. First, the HFDIB framework is extended toward Reynolds-averaged simulations through the incorporation of turbulence models and wall-function-based boundary treatment. Second, computational efficiency of particle contact resolution is enhanced using an adaptive R-tree-based virtual mesh, enabling accurate overlap-volume evaluation at substantially reduced cost. Third, a model order reduction methodology based on shifted proper orthogonal decomposition and artificial neural networks is introduced and its potential for construction of efficient reduced-order surrogates for particle-laden flows is discussed.

Termin: **13.11.2026, 13:00 Uhr**
Ort: **Zeuner-Bau, Raum 150a**

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