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An Explicit Finite-Difference Scheme for Particulate Flows with a New Treatment of Boundary Conditions Based on Stokes Flow Solutions ANDREW PERRIN, HOWARD HU, University of Pennsylvania — We have developed an explicit finite-difference scheme for direct simulation of the motion of solid particles in a fluid. It is challenging to enforce the no-slip condition on the surface of circular particles in a uniform grid. In this study, we have implemented a treatment of the boundary condition similar to that in the PHYSALIS method of Takagi et. al. (2003), which matches Stokes flow solutions next to the particle surface with a numerical solution away from it. The original PHYSALIS method was developed for implicit flow solvers, and required an iterative process to match the Stokes flow solutions with the numerical solution. However, it was easily adapted to work with the present explicit scheme, and found to be more efficient since no iterative process is required in the matching. The method proceeds by approximating the flow next to the particle surface as a Stokes flow in the particle's local coordinates, which is then matched to the numerically computed external flow on a "cage" of grid points near the particle surface. Advantages of the method include superior accuracy of the scheme on a relatively coarse grid for intermediate Reynolds numbers, ease of implementation, and elimination of the need to track the particle surface. A disadvantage is that fine grids are required for Reynolds numbers greater than 200. Several examples are presented, including flow over a stationary cylinder, dropping, kissing, and tumbling of two particles, and a dense particulate sedimentation problem.

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