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A 3D Explicit Finite-Difference Scheme for Particulate Flows with Boundary Conditions based on Stokes Flow Solutions A. PERRIN, H. HU, University of Pennsylvania — We have extended previous work on an 2D explicit finite-difference code for direct simulation of the motion of solid particles in a fluid to 3D. It is challenging to enforce the no-slip condition on the surface of spherical particles in a uniform Cartesian grid. We have implemented a treatment of the boundary condition similar to that in the PHYSALIS method of Takagi et. al. (2003), which is based on matching the 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 particles 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 the elimination of the need to track the particle surface. Several examples are presented, including flow over a stationary sphere in a square tube, sedimentation of a particle, and dropping, kissing, and tumbling of two particles. This research is supported by a GAANN fellowship from the U.S. Dept. of Education.

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