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DESCENT OF A SOLID DISK IN QUIESCENT FLUID SIMULATED USING INCOMPRESSIBLE SMOOTHED PARTICLE HYDRODYNAMICS

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The interaction of a solid body with a fluid environment is one of the most common flow features in nature and industry covering a gamut of phenomena from the motion of a school of fish within water to rotating blades of a pump. As such, it has been the subject of interest for many research studies involving computational fluid dynamics [1, 2]. Particle methods are particularly suited for these problems as discretization points may move with the solid body and conform to the boundaries [3, 4].

In this study, a two dimensional Incompressible Smoothed Particle Hydrodynamics (ISPH) scheme based on the projection method proposed by Cummins and Rudmann [5] is developed to simulate the interaction between a passive solid object and the surrounding fluid. The scheme is based on single domain model where all phases within the system are treated as fluids with different viscosities [1, 6] while the solid phase is represented by particles of fixed relative configuration. As such, the value of viscosity chosen and the scheme of interpolation used to transition between the solid and fluid phases are of utmost importance in accurate representation of the physical phenomenon. Weighted harmonic averaging and a viscosity ratio of 100 is found to provide satisfactory results and is employed to perform a simulation of a solid disk of diameter d settling in a quiescent fluid under gravity. Taking d as the length scale of the problem, the computational domain consists of an 8×24 rectangle with the disk initially positioned at $(4, 16)$. Upon release, the disk passes through acceleration, constant velocity descent and deceleration phases, finally resting at the bottom of the computational domain. The results of the simulation are provided in figure 1. The right portion of the figure provides velocity vectors and contours of velocity magnitude on the left column and streamlines and pressure contours on the right column at $y/d = 6$, when the disk is descending at its terminal velocity. Figure

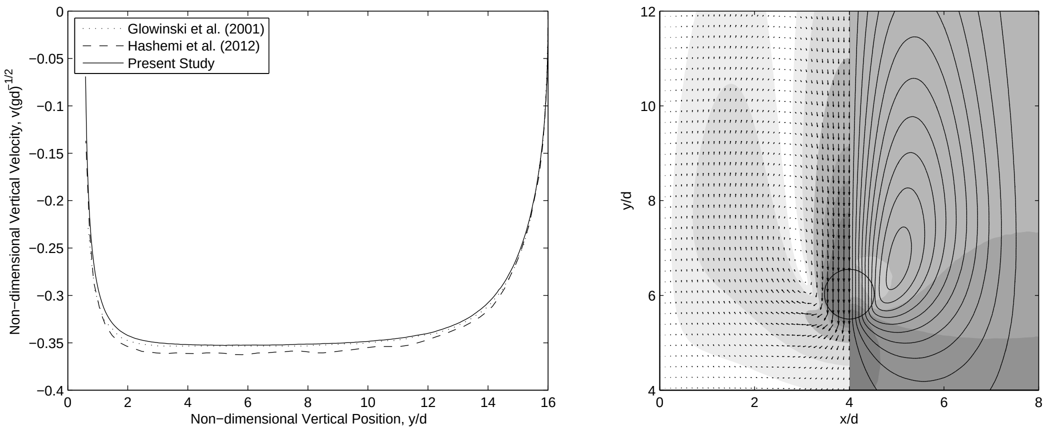

Figure 1: (Left) Comparison of vertical velocity of descending disk with respect to vertical position. (Right) Close up of the disk at $y/d = 6$, descending at its terminal velocity; Left Column: velocity vectors and contours of velocity magnitude; Right Column: streamlines and pressure contours.

1-left shows the comparison of vertical velocity versus vertical position of the disk's center of mass compared with the Weakly Compressible SPH (WCSPH) simulations of Hashemi *et al.* [4] and fictitious domain approach of Glowinski *et al.* [1]. The proposed scheme is able to capture the motion of the disk within the quiescent medium with quantitative accuracy.

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