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A GPU-accelerated flow solver for incompressible two-phase fluid flows STEPHEN CODYER, MEHDI RAESSI, GAURAV KHANNA, University of Massachusetts Dartmouth — We present a numerical solver for incompressible, immiscible, two-phase fluid flows that is accelerated by using Graphics Processing Units (GPUs). The Navier-Stokes equations are solved by the projection method, which involves solving a pressure Poisson problem at each time step. A second-order discretization of the Poisson problem leads to a sparse matrix with five and seven diagonals for two- and three-dimensional simulations, respectively. Running a serial linear algebra solver on a single CPU can take 50-99.9% of the total simulation time to solve the above system for pressure. To remove this bottleneck, we utilized the large parallelization capabilities of GPUs; we developed a linear algebra solver based on the conjugate gradient iterative method (CGIM) by using CUDA 4.0 libraries and compared its performance with CUSP, an open-source, GPU library for linear algebra. Compared to running the CGIM solver on a single CPU core, for a 2D case, our GPU solver yields speedups of up to 88x in solver time and 81x overall time on a single GPU card. In 3D cases, the speedups are up to 81x (solver) and 15x (overall). Speedup is faster at higher grid resolutions and our GPU solver outperforms CUSP. Current work examines the acceleration versus a parallel CGIM CPU solver.

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