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Acceleration of Lagrangian and Eulerian Flow Solvers via Graphics Processing Units

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Abstract : There are many computationally demanding applications in science and engineering which need efficient algorithms implemented on high performance computers. Recently, Graphics Processing Units (GPUs) have drawn much attention as compared to the traditional CPU-based hardware and have opened up new improvement venues in scientific computing. One particular application area is Computational Fluid Dynamics (CFD), in which mature CPU-based codes need to be converted to GPU-based algorithms to take advantage of this new technology. In this paper, numerical solutions of two classes of discrete fluid flow models via both CPU and GPU are discussed and compared. Test problems include an Eulerian model of a two-dimensional incompressible laminar flow case and a Lagrangian model of a two phase flow field. The CUDA programming standard is used to employ an NVIDIA GPU with 480 cores and a C++ serial code is run on a single core Intel quad-core CPU. Up to two orders of magnitude speed up is observed on GPU for a certain range of grid resolution or particle numbers. As expected, Lagrangian formulation is better suited for parallel computations on GPU although Eulerian formulation represents significant speed up too.

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