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SOLVING INCOMPRESSIBLE 3D VISCOUS FLUID FLOWS USING CUDA

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Abstract. In recent years GPGPU's (General Purpose Graphic Processing Units) area being used in HPC (High Performance Computing), specially for problems that can be solved with CA (Cellular Automata) algorithms. In particular, a great effort is being oriented to exploit the great computing power of this hardware to fluid mechanics problems.

Our objective is to develop an incompressible Newtonian fluid solver that can be used on real time. In this way, on previous works, explicit schemes were only considered. The momentum equations were solved using QUICK (Quadratic Upstream Interpolation for Convection Kinematics (QUICK), as stabilization schema; who preserves third order error truncation on spatial dimension but, nevertheless, requires a large stencil in order to make the calculations. Also, the time step was highly limited.

In this work we implement a more efficient method in order to solve transport equations. The advection is solved using a method called BFECC (Back and Forth Error Compensation and Correction), that is based on solving with the advection operator forward in time, then back; using this information to compute a correction that is forwarded altogether with the initial field. As a result numerical diffusion is reduced.

This scheme is specially suited for implementation on the GPGPU's because it has a very low numerical diffusion while keeping a very compact stencil.