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An implicit multigrid solver for high-order compressible flow simulations on GPUs

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Multigrid algorithms are among the fastest iterative methods known today for solving large linear and non-linear system of equations. In this study, the efficiency of the proposed parallel multigrid solver for 2D inviscid compressible flow simulations on Graphics Processing Unit (GPU) is investigated. The Beam and Warming linearization scheme and Alternate Directional Implicit (ADI) method are used for time advancement. The second-order central and fourth-order compact finite difference schemes are applied to spatial discretization. A high-performance GPU solver optimized for large scale CFD applications is presented which utilized the efficient implementation of cyclic reduction algorithm for the parallel solution of block-tridiagonal systems. Attention is directed towards the computational performance of the V-cycle and W-cycle multigrid strategies for single and double precision accuracy on NVIDIA GTX480 graphics card. The experimental evaluation of the proposed solver demonstrates a significant reduction in computational runtime.

Keywords: multigrid, Block-tridiagonal solver, GPU Computing, Compressible flow, 2D Euler equations